Established 1916 as The OIL WEEKLY®

VOLUME 152, NO. 2 FEBRUARY 1, 1961

WORLD OIL

A Gulf Publishing Company Publication

SPECIALIZED FOR EXPLORATION, DRILLING AND PRODUCING OPERATIONS AND MANAGEMENT

CURRENT OUTLOOK

Shell announces two technical break-throughs 9

Why World Oil's circulation increased 22.5 percent in five years 11

Gasoline surplus is threat to industry 13

U.S. rig activity at 19-year low 16

87th Congress holds 10 keys to the future of oil and gas 68

EXPLORATION

Oil basins surround the Arctic Ocean
Leonid Smirnow 27

Many geologic factors govern waterfloods
Hal W. Yeager, Jr. 46

DRILLING

New technique increases core recovery
C. F. Knutson, E. W. Sutton and *R. J. Cavanaugh* 37

How different mud additives affect R_m — R_{mf} — R_{mc} ratios
Dr. Hamilton M. Johnson 49

PRODUCTION

Technical-operating details of production operations in Algeria's Hassi Messaoud field
R. J. Rousseau 23

Flowing well logs can save you money
H. L. Bryant 33

Radioactive gas tracer survey aids waterflood planning
W. D. Howell, F. E. Armstrong and *J. Wade Watkins* 41

DEPARTMENTS

Oil industry in brief	4	Associations	92
Looking ahead	9	Who's meeting where	95
Editorial page	11	Suppliers' notes	96
Changing panorama	13	Trading post	98
Drilling activities	16	Classified advertising	98
Practical operating hints	20	Squeaks from the bullwheel	100
Men in the industry	88	What's new in equipment	102

Advertisers in this issue 110

WORLD OIL published every month except semi-monthly in Feburary and August. Second class postage paid at Houston, Texas. ©Gulf Publishing Co. 1961.

A Quick Look at This Issue

BUSY OIL MEN: To help you put first things first, scan these time-saving digests on this and the following pages, checking ☑ those you want to read first.

☐ **Production operations in Algeria's Hassi Messaoud field . . .** French operators are faced with lost circulation, high pressure salt water flows, asphaltic tubing deposits, bottom hole sediments, ineffective well stimulation treatments and involved workover jobs. For the first complete technical-operating article on Hassi Messaoud, turn to ..... Page 23

☐ **Oil basins surround the Arctic Ocean . . .** Thick Paleozoic sedimentary sections spotted with reefs, evaporites, diapirs, and salt domes are present in both Free World and Russian portions of the Arctic. Proximity of some of these areas to Western European markets portends a race to develop their oil potential. . . . Page 27

☐ **Flowing well logs can save you money . . .** Substantial savings in rig time, reduction of production and exploitation expenses, and increased recoveries are a few of the benefits realized from such operations. In addition, early use of the technique can lead to increased secondary recovery. For complete details on the way one company utilizes flowing well logs, see ..... Page 33

☐ **New technique improves core recovery of unconsolidated sands . . .** Continental Oil Company has evaluated several cores from unconsolidated Gulf Coast Miocene and Oklahoma basal McLish formations using rubber sleeve core barrels. In the past, the recovery from these zones was 0-20 percent; however, while using the technique, 90 percent or better was recovered. For an informative report on Continental's field and laboratory experience with this new coring method, turn to ..... Page 37

☐ **Radioactive gas tracer survey aids waterflood planning . . .** Used successfully in West Texas' Spraberry formation, survey permits operators to properly space wells and take full advantage of fracture orientation. Method is applicable in many limestone formations. For an informative case history of the Spraberry project, turn to .....Page 41

☐ **Many geologic factors govern waterfloods . . .** Geologists are taking an increasing role in planning waterfloods. Close attention to such considerations as aquifer—pay zone relationships, bedding planes, thin high-permeability zones, swelling clays, and ground water supplies can help make a waterflood project profitable. Ignoring such aspects may result in failure, loss of recoverable oil, and loss of money.....Page 46

☐ **How different mud additives affect R_{xo}-R_{mf}-R_{mc} ratios . . .** Resistivity measurements of mud-affected cylinders separating the logging tool from virgin formations must be accurately ascertained for optimum use of recorded logs. For complete details on the most effective ways to measure and evaluate these measurements, turn to.....Page 49

☐ **10 keys to the future of oil and gas . . .** Realizing the impact the 87th Congress will have on every oil and gas operator, WORLD OIL, with the aid of Washington correspondent Frank C. Adams, has prepared a detailed analysis of the most important oil and gas issues—their current status and expected action to be taken. The report was obtained from personal interviews with company officials, oil and gas association leaders, senators, congressmen, and administration personnel most closely associated with each issue. For the most informative discussion yet presented on this important subject, turn to.....Page 68

Index keeps engineers informed

AS MANY of our readers indicate, one of the handiest references in an engineer's file is WORLD OIL's annual Editorial Index. It is a "must" for several hundred company and college libraries. It is free to all readers requesting a copy.

The new Index, just off the presses, lists in easily-referred-to sequence all the articles on technical developments in drilling and production, geology, new exploration methods, most active drilling areas, and oil industry economics that appeared in the 14 issues of WORLD OIL published during 1960.

Many copies of the 1960 Index were ordered several weeks in advance of publication. The supply is limited, so address your order *now* to: Librarian, Gulf Publishing Company, Post Office Box 2608, Houston 1, Texas. Or if you prefer, use the convenient Reader Service Blue Postcard just inside the back cover of this and every issue of WORLD OIL. Check the square indicated, fill in your name and address, and drop the postage-paid card in the mail today.

Oil Industry In Brief

Here are the latest industry trends, revealed by WORLD OIL and industry research.

Total demand eases upward. Demand for all oils averaged 9.7 million bpd last year, up 1.9 percent over 1959. Crude oil and natural gas liquids production averaged 7.9 million bpd.

Gasoline demand down. December gasoline demand dropped 146,000 bpd, or 3.6 percent below same 1959 period. Gasoline demand for the year was up only 42,000 bpd, or 1 percent . . . See Page 13.

Stocks too high. As new year opened, gasoline stocks topped 197 million barrels, up 10 million barrels or 5.2 percent over same 1960 date—posing serious threat to industry's economic position . . . See Page 13.

Political tempo increases. A.P.I., I.P.A.A., and other industry groups have publicly announced support of national fuels policy study, but not end use controls . . . As he bowed out, Eisenhower called for hike in gasoline tax, change in residual import plan; however, Congress will do nothing until it hears from its new chief . . . Treasury Secretary Dillon says changes in depletion provision may be forthcoming this spring.

Completions Drop. 46,778 new U.S. well completions were reported in 1960, down 3,401, or 6.8 percent from 1959 —and 11,340 wells less than peak year of 1956 . . . See Page 16.

Rig activity slumps to 19-year low. At year's end, 3,511 rigs were reported operating in the U.S., down 109 from November, down 383 from same 1959 date—the lowest total for same date since war year of 1942 . . . See Page 16.

Technical progress moves ahead. Shell Oil has announced two major breakthroughs—remotely controlled underwater completion off Louisiana coast and corrosion detector that uses electro-magnetic wave to spot a thinning on both sides of well casing only 1/200th of an inch deep . . . See Page 9.

February 15 Issue Your Biggest Reading Value Yet

In two weeks you will receive World Oil's Forecast-Review Issue—the most highly respected oil industry statistical report published.

Why can World Oil make this statement? When evaluating forecast-review statistics published by various sources, oil men must carefully weigh three important factors: Experience—Accuracy—Completeness.

Here is the World Oil record in these departments:

• **Experience.** The 1961 Annual Forecast-Review Issue will be the 43rd to be issued by the Gulf Publishing Company—one of the industry's oldest, most reliable statistical reports.

• **Accuracy.** World Oil's statistical forecasts are known throughout the industry for accurateness. Past and future well completions, footage drilled, production, etc. are not pulled from a hat, nor are they assumed from historical trends. They are the result of extensive surveys conducted in every oil and gas producing state.

To give but one example of World Oil's accuracy, the editorial staff's mid-year forecast for U.S. well completions was 46,324 wells. The actual total for 1960 was 46,778 wells—*454 wells, or less than 1 percent less than the World Oil forecast made six months earlier!*

• **Completeness.** Few forecast-reviews, if any, have the scope of World Oil statistics. Virtually every phase of exploration, drilling, production, international operations, and future trends is covered in detail, based on well-documented facts. In addition to the information-packed statistical reports, three special reports introduced last year will again be published. They are:

Outlook for U.S. exploration in 1960. Timely reports and key maps will point out significant exploration and drilling to be expected in all states and districts.

New drilling equipment and methods. A review of the technical progress made in 1960, plus a look at future trends in development of new methods and equipment.

New production methods. A comprehensive look at the past and future of improved techniques in production operations. Included will be descriptions of the latest developments in well completions, perforating, formation fracturing, artificial lift, gas-oil separation, storage, etc.

In short, you can confidently expect one of the top publication values of 1961 when the February 15 Forecast-Review Issue reaches your desk.

Be sure to watch for it.

WORLD OIL

Ray L. Dudley, Founder, 1891-1957

William G. Dudley.....Publisher
Donald E. Kliewer.....Editorial Director
L. J. Logan.....Associate Editor
Don E. Lambert.....Associate Editor, Current Outlook
Wallace Fitzgerald.....Managing Editor
Robert W. Scott.....Engineering Editor
Jack F. Earl.....Engineering Editor
Harrison T. Brundage.....Exploration Editor
Gilbert M. Wilson.....Western District Editor
Anthony Gibbon.....Mid-Continent District Editor
Jack Cockerham.....Presentation Editor
Fern C. Reed.....Editorial Assistant
John Bradley.....Editorial Assistant
Dolores Reynolds.....Editorial Assistant
Gary Dunham.....Editorial Assistant
Eunice M. Okoneski.....Librarian

WORLD OIL
Is Published By
GULF PUBLISHING COMPANY

Executive Offices: 3301 Buffalo Drive, Houston
Cable Address, Gulfpubco, Houston
World's Largest Specialized Publishers to the Oil Industries

William G. Dudley.....President
Tom W. Nelson.....Vice Pres.-Gen. Mgr.
R. M. de Sombre.....Vice Pres.-Asst. Gen. Mgr.
Nelson L. Bigelow.....Vice President Sales
Mrs. Ray L. Dudley.....Vice President
P. J. Aucoin.....Treasurer

ADVERTISING

Nelson L. Bigelow, Advertising Sales Manager, Houston

Houston (1)—P. O. Box 2608
Charles Wyatt, C. A. Davis, Cecil W. Smith
Phone JAckson 9-4301

Summit, New Jersey—382 Springfield Ave.
Sam Sorrell, Phone CRestview 7-1221

Cleveland (16)—20800 Center Ridge Road
Bill Westfall, Phone EDison 3-1650

Chicago (46)—6039 N. Cicero Avenue
Al Seymour, Phone AVenue 2-4333

Los Angeles—1810 Fair Oaks Ave., South Pasadena
Jay Curts, Jim Merrill, Phone MUrray 2-3518

Tulsa (3)—916 Enterprise Building
Jim Isaacks, Phone LUther 2-9211

Dallas (8)—1808 Sylvan Drive
Ed Thompson, Phone RIverside 7-7344

London, England—120 Moorgate, E. C. 2
Frank Chambers, Agent, Phone MOnarch 5661

Koln-Braunsfeld, Germany—Aachener Strasse 378,
Gerd Hinske, Phone 52 22 60

Advertising rates on application.

SUBSCRIPTIONS

R. B. Reilly, Circulation Manager, P. O. Box 2608, Houston 1, Texas, U.S.A. Single copies 50 cents (except special issues). Double prices for single copies more than a year old. Subscription rates: both foreign and domestic $2 a year.

Copyright 1961 by Gulf Publishing Company. WORLD OIL and THE OIL WEEKLY are registered trademarks of Gulf Publishing Company, Houston, Texas.

Postmaster: Send notification (Form 3579) regarding undeliverable magazines to WORLD OIL, Box 2608, Houston 1, Texas.

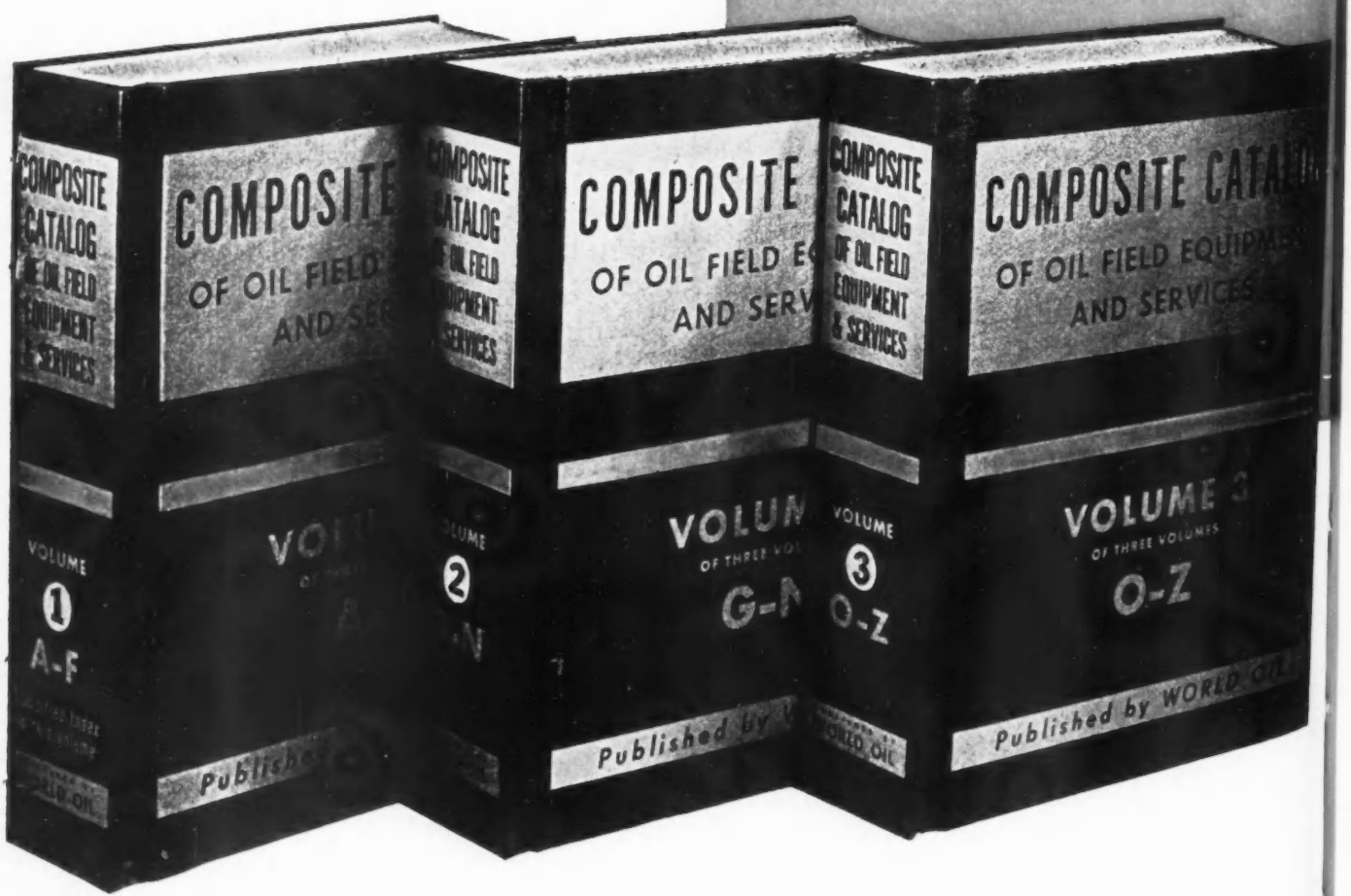
GPC PUBLICATIONS

WORLD OIL (formerly The Oil Weekly) and The COMPOSITE CATALOG for the drilling-producing industry.
PIPE LINE INDUSTRY and The PIPE LINE CATALOG for the oil and gas pipe line industry.
PETROLEUM REFINER and The REFINERY CATALOG for the hydrocarbon processing industry.

Indexed by Industrial Arts Index and Engineering Index

At the Rig Or in the Office

- More than 500 Individual Company Catalogs
- Over 5,000 Pages of Equipment Information
- Indexed and Cross-Referenced
- Fast, Accurate, Current Reference



COMPOSITE CATALOG OF OIL FIELD EQUIPMENT AND SERVICES

Published by World Oil, P.O. Box 2608, Houston

Looking Ahead

'61 Prediction: slight decline in drilling activity . . . World Oil forecasts 46,079 new well completions this year, down 699 wells or 1.5 percent from '60 total of 46,778 wells (See Page 16). Footage drilled will drop from 194.5 million feet in '60 to 191.3 million this year.

Commerce department paints rosier picture . . . Business and Defense Services Administration says its crystal ball shows 1,000-1,500 more wells will be drilled in the U.S. this year—operating rotary rig averages will increase to 1,850, from 1,735 last year.

Reasons: Improved inventory position at year's end—5 percent increase in company earnings during first 9 months of '60—this year's company budgets are running about 5.6 percent ahead of last year—product prices have started to improve.

While U.S. and overseas shipments of oil field machinery and equipment were down 10 percent during '60, total dollar volume increased about 7.3 percent to $850-$860 million, reports the U.S. Census Bureau. Export shipments totaled $189 million, up 7 percent over 1959.

Shell announces two technical breakthroughs . . . Underwater Completion #2 and instrument that detects corrosion on both sides of well casing.

Underwater completion is Shell's second off Louisiana shores, but first to be used on a producing well. Although refusing to give technical details on new method, Shell reports it should give big boost to offshore oil and gas operations. The 8,300-foot well is located in 56 feet of water in West Cameron Block 192 field, 35 miles off Louisiana coast. Completion, made by remote control, eliminates need for platforms and divers.

Corrosion detector measures thickness of casing walls with electro-magnetic wave, can spot a thinning 1/200th of an inch deep. As exciter coils are lowered into well, instrument reports changes in wall thickness by fluctuations in waves' travel time. Instrument, lowered by single conductor cable, operates to about 15,000 feet. Its logs are not distorted by mud, scale or well fluids, has logging speed of 1,800-3,600 feet per hour.

Oil industry equipment and vehicle leasing in upward trend . . . Value of production and office equipment leased to oil firms increased 27 percent to $38.7 million, while value of auto and truck fleets moved upward 10.4 percent to $25.4 million.

Reasons: (1). Increased popularity of sale-leaseback transactions involving existing plant. (2). More equipment manufacturers have introduced lease plans. (3). Money remains tight, as evidenced by 13 percent decline in corporate liquidity in the oil industry during 1960. (4). Greater use of open-end "master lease" allowing companies to expand their leasing steadily, as need for additional equipment arises.

New Libyan discovery undergoing fast evaluation . . . New oil find on Block 20 in the Sirte Basin by Esso Sirte and Libyan-American Oil Company west of Zelten and north of Amoseas' Beda field appears to be another major discovery. Pay was topped at 5,283 feet—top of quartzite was 5,531 feet. Well reached basement at 5,563 feet. There appears to be 80-100 feet of gas cap above the oil. Well tested 2,250 bpd on a ¼-inch choke, but might have made 5,000 bpd had tankage for adequate tests been available. Stepouts are being drilled 2 miles east, and another 4 miles north of discovery well.

One of world's oldest plays is still alive . . . Esso Hellenic, Inc., will drill an 8,000-foot or deeper test in southwestern Greece to test Cretaceous, Jurasic and possibly older formations. Asphalt from seeps on Zakynthos (Zante) Island was used as early as 450 B.C. to caulk ships of ancient Greeks. Some shallowstripper oil was produced after World War I, but Esso's is first deep test.

Good Wells Make Good News

A Report on Some Unusually Successful Recent Frac Jobs

February, 1, 1961

Here are four recent examples showing how Dowell fracturing services have helped operators increase oil and gas production and profits.

- **Butler County, Kansas** (Waterflood Producer) Production from this Kansas City lime well had declined to 4 bopd and 30 bwpd. Dowell engineered a treatment using the Frac Guide*. 5000 gallons of acid-oil emulsion carried 10,000 pounds of 20-40 mesh sand into the formation at 12 bpm. 140 days after treatment, production was 81 bopd and 106 bwpd.

- **Panola County, East Texas** (Old Gas Well) Gas delivery from this well into the 300-psi line had declined to 200 mcfd. The well had been producing from eight perforated intervals between 6068 and 6434 feet in the Travis Peak formation. The total perforated pay was 111 feet -- 70 of which looked good on logs. Dowell engineers fractured the well using 100,000 gallons of gelled water and 70,000 pounds of 20-40 mesh sand -- 1000 pounds sand per foot of good pay. As each interval was fractured, perforation ball sealers were injected to divert fracturing fluids to another zone. Injection rate averaged 24 bpm at pressures ranging from 2500 to 4000 psi. After treatment, delivery to line was 1200 mcfd, a net increase of 1000 mcfd. Payout was fast -- approximately 1½ months.

- **Jones County, Northwest Texas** (New Oil Well) This tubingless completion was made into the Canyon sand through five sets of perforations between 3864 and 4039 feet. Initial test was almost two boph but operator wanted to stimulate so top allowable would be assured. Dowell engineered a treatment using the Frac Guide. 40,000 gallons lease oil with FLA* (Fluid Loss Additive) and 80,000 pounds sand were injected down 2½-inch casing at 12 bpm and 3400 psi. After treatment, well potentialed 1560 bopd -- a 30-fold increase.

- **San Juan County, New Mexico** (New Gas Well) This development well was drilled into the Dakota sand between 6698 and 6774 feet. Permeability was so poorly developed, compared to other wells in the area, that abandonment was considered. However, operator decided to complete the well, using Abrasijet* -- abrasive jetting service -- and fracturing. With Abrasijet, Dowell cut five notches into formation at 6698, 6704, 6756, 6768 and 6774 feet. About 20,000 pounds of sand was used. Dowell then fractured using water to carry 30,000 pounds of sand at about 35 bpm. Well potentialed 2500 mcfd -- similar to other wells in the field. Operator believes $4500 treatment made an economic producer out of what would otherwise have been a dry hole.

Your Dowell engineer has many services and products to help you improve net profits on your operations. For service or more information, dial Dowell. Dowell services and products are offered from more than 150 offices and stations in the United States, Canada, Venezuela, Argentina, Germany, France and the Sahara area. Dowell, Tulsa 1, Oklahoma.

*DOWELL TRADEMARK

Services for the oil industry

DOWELL

DIVISION OF THE DOW CHEMICAL COMPANY

Memo To: Subscribers

Why WORLD OIL's circulation increased 22.5 percent in five years

YOUR ACCEPTANCE of WORLD OIL's leadership in reader service and editorial quality has made it possible to make this report . . . The December 1960 circulation statement submitted to the Audit Bureau of Circulation shows WORLD OIL now has 26,398 subscribers—*more than any other publication specialized for the exploration, drilling and production phases of the oil and gas industry.*

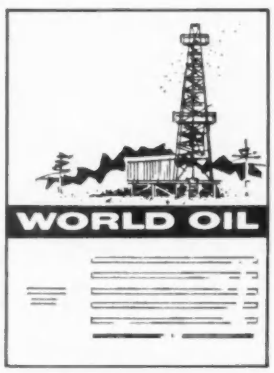
Here are five reasons why WORLD OIL circulation has followed the industry's growth:

• Editorial Tailored to the Reader's Needs.

Following a long established policy, WORLD OIL's editorial program is geared to the men most interested in keeping abreast of technical developments — who have the greatest influence in the purchase of oil field equipment.

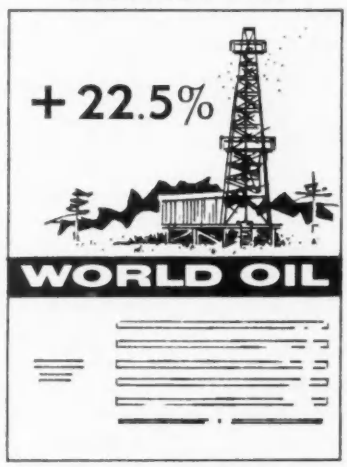
Proof that WORLD OIL is the industry's leading technical-operating publication is presented in these statistics: During 1960, WORLD OIL carried 555 pages of technical articles — 45.3 percent of the editorial content. The next leading publication specialized for exploration, drilling and production carried 330 pages—31.7 percent of total editorial. The two leading general interest oil publications published 13.1 percent and 8.4 percent technical-operating material covering exploration, drilling and production.

DECEMBER 1955



21,542 SUBSCRIBERS

DECEMBER 1960



26,398 SUBSCRIBERS

• Leader in New Ideas.

Sextuple and underwater completions—technical report on Gulf Oil Corporation's drilling records—promising oil and gas areas—latest technical developments in exploration—most complete analyses of oil industry economics and political activity published—these are just a few of the editorial "firsts" scored by WORLD OIL during 1960. Three Engineering Practices Manuals were introduced to the industry last year,* representing a new idea that has sold more than 6,000 reprints to date.

• Balanced Article Selection.

Much of WORLD OIL's editorial success can be attributed to a strict screening plan that permits only the most informative, complete and accurate articles to appear in the magazine. The field-experienced editorial staff handles hundreds of articles each year. Only the most outstanding pass the test for publication.

• The Most Accurate Statistical Reports Available. WORLD OIL is second to none in this department. At mid-year, WORLD OIL forecast 46,324 new well completions for 1960. The actual total was 46,778 wells, for a 99.02 percent accuracy mark. Also, it was predicted that 193,996,893 feet of hole would be drilled. The final total was 194,583,142 feet—less than 600,000 feet, or 0.31 percent from a perfect forecast.

WORLD OIL's monthly statistics, Forecast-Review Issue and International Outlook Issue long have been regarded as the most complete and accurate statistical reports published for the oil industry.

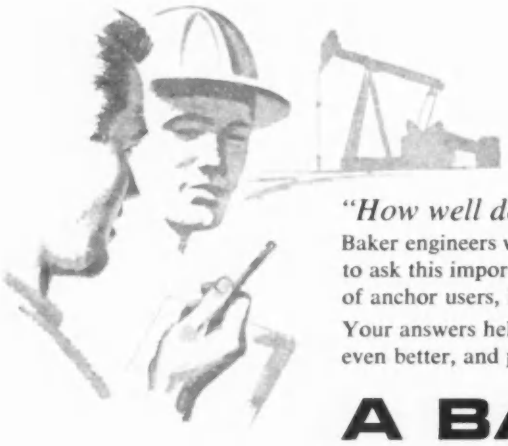
• More Attractive, Readable Format.

Three years ago, WORLD OIL completely changed its appearance. A new front cover was introduced, monthly editorial departments were reorganized and presented in a more readable form, new layout ideas were used, type faces were changed.

The results are reflected in WORLD OIL's growing circulation, written and verbal comments from a large number of subscribers, plus the record total of more than 102,000 reprints of WORLD OIL articles sold last year.

Since WORLD OIL is recognized as the most valuable reading bargain in the oil and gas industry, why not tell your friends about it? Why not tear out the attached subscription blank and pass it on?

* Producing Equipment for Natural Gas Wells—Fishing Manual—Care and Maintenance of Tool Joints.



"How well does it work?"
Baker engineers went out into the field to ask this important question of dozens of anchor users, large and small.

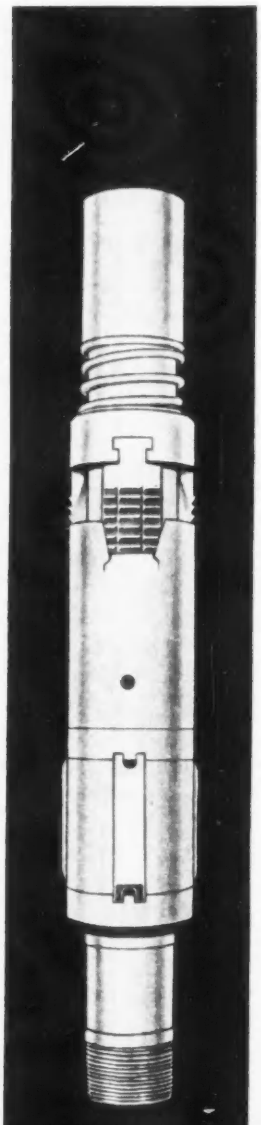
Your answers helped us to make a good tool even better, and proved again that . . .

A BAKER COMPENSATING TUBING ANCHOR

Reduces Rod and Tubing Wear as evidenced by the need for fewer pulling jobs.

Increases Pumping Efficiency as measured in more barrels of oil, reduced pumping speeds or lower power consumption.

Really Does Compensate as indicated by the need to respace pumps after several days use, or by the upstrain required to release doughnut-type hangers—or, most importantly, by the results obtained.



The Baker Compensating Tubing Anchor has been on the market a little over three years. It has proved its ability in hundreds of wells and recent changes make it even better.

Because it automatically compensates for changing well conditions, it maintains the right amount of tension at all times to effectively eliminate breathing and buckling. It's easy to run—no involved calculations, no need to apply tension from the surface.

A careful study of hundreds of field reports reveals not one reported instance of inability to retrieve a Baker Compensating Anchor where the casing above the anchor was in good condition and to gauge. And recent design improvements now insure easier removal with greater freedom from corrosion.

The economics of today's oil industry make it more important than ever to explore every possible means of cutting costs and improving efficiency. Baker honestly believes that the Compensating Tubing Anchor is one such means. Your Baker Man has the facts on this tool's past performance, and on the several ways it has been improved. Ask him.

TYPICAL FIELD REPORTS

Kansas: Operator ran anchor in an attempt to cut down tubing leaks (seven leaks in previous three months). In the twelve-month period following installation of a Baker Compensating Tubing Anchor he has had only two tubing leaks and has increased pump efficiency by approximately 43%.

Texas: Operator had run twenty-five Baker Compensating Tubing Anchors and was very pleased with results. As a test, he released the Baker anchor in a well that was making 140 barrels per day. After release (tubing string unanchored) he reported that production fell off to 75 barrels per day. After resetting anchor, production went back to 140 barrels per day.

Eastern Colorado: Operator has run 40 Baker Compensating Anchors. Had not previously used anchors. Ran anchors to reduce frequency of tubing jobs to replace rod-cut tubing. Reported that he had eliminated rod-cut tubing, increased pump life 100% and production 14%.

BAKER

BAKER OIL TOOLS, INC. HOUSTON • LOS ANGELES • NEW YORK

Gasoline surplus is threat to industry

By **WORLD OIL Staff**

INCREASING STOCKS of gasoline continue to represent the principal threat to the lately improved situation of the oil industry. As the new year opened, gasoline stocks totaled 197 million barrels, an increase of 10 million barrels or 5.2 percent over one year previously.

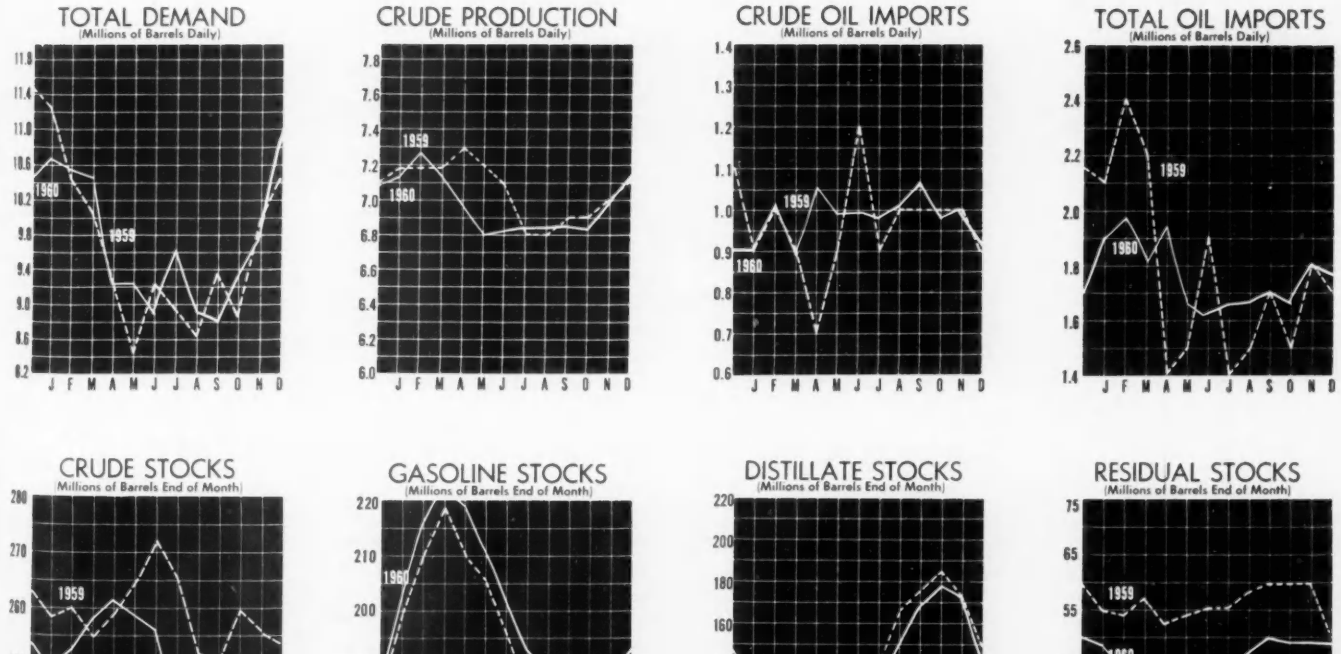
This increase was not justified by the trends of demand for gasoline. Total demand for gasoline in December 1960 was 146,000 barrels per day or 3.6 percent lower than in the same month of 1959. And for the whole year 1960 gasoline demand was up only 42,000 bpd or 1 percent, having averaged 4,154,000 bpd.

The surplus of gasoline increased by a large amount in December. At the close of November the stocks had been only 6.3 million barrels or 3.5 percent over one year previously, compared with the December 31 increase of 10 million barrels or 5.2 percent.

The large build-up of the gasoline surplus in December probably was to some extent unavoidable because of exceptionally cold weather. The severe weather caused heavy consumption of distillate fuel oil and encouraged relatively high crude runs to stills for making additional distillate. The large refinery runs in turn resulted in additional production of gasoline.

While the cold weather had adverse significance for the gasoline situation, it favorably affected the industry from the standpoint of distillate fuel oil business. Demand for distillate in December averaged 3 million barrels daily, up 350,000 bpd or 13.2 percent over December 1959, which was a warmer month. In November 1960 distillate sales had lagged because the weather was milder than in November 1959. For the whole year 1960 distillate demand was up 54,000 bpd or 2.9 percent over 1959.

Petroleum Trends...



U.S. Drilling Activity in December and Years 1960-1959

STATE or DISTRICT	TOTAL NEW WELLS COMPLETED AND FOOTAGE DRILLED — DETAILS FOR DECEMBER, 1960: Oil	Dist.	Gas	Dry	Service Wells	TOTAL NEW WELLS: Dec. 1960	Nov. 1960	Dec. 1959	Total Footage December 1960	DETAILS FOR YEARS 1960-1959 — NEW WELLS: 1960	†1959	Percent Diff.	FOOTAGE: 1960	†1959	WILDCAT DRILLING IN YEARS 1960 AND 1959 — DETAILS FOR DEC., 1960: Oil	Dist.	Gas	Dry	Total Wildcats	DETAILS FOR YEAR: Oil	Dist.	Gas	Dry	TOTAL WILDCATS: 1960	1959	DRILLING RIGS IN OPERATION (Rigging up, Drilling, Temp. Shut-Down): Dec 31, 1960	Nov. 30, 1960	Dec. 31, 1959
Alabama	1	....	....	2	....	3	1	9	18,240	52	108	— 51.9	470,425	976,926	....	....	....	2	2	....	....	....	10	10	30	9	7	6
Alaska	3	....	....	1	....	4	2	4	41,426	24	14	+ 71.4	240,969	141,670	....	....	....	1	1	1	....	1	7	9	9	8	8	7
Arizona	....	....	....	....	....	....	1	6	....	26	36	— 27.8	67,467	94,329	....	....	....	....	....	1	....	....	21	22	35	3	6	2
Arkansas	19	....	4	20	....	43	56	58	172,112	591	814	— 27.4	2,129,789	2,728,131	....	....	....	7	7	3	1	3	111	118	129	38	43	45
California	197	....	11	47	1	256	172	169	851,846	1,691	1,520	+ 11.3	7,145,783	7,240,301	1	....	3	22	26	11	....	11	272	294	327	139	139	126
Colorado	12	....	16	60	1	89	82	64	477,446	694	726	— 4.4	3,548,526	3,818,603	4	....	1	33	38	20	....	9	303	332	390	47	67	42
Illinois	35	....	....	59	....	94	153	121	205,487	1,922	2,033	— 5.5	4,099,491	4,492,151	1	....	....	27	28	10	....	1	616	627	499	268	267	324
Indiana	26	....	2	60	....	88	92	75	129,509	1,010	809	+ 19.7	1,405,822	1,332,939	....	....	....	19	19	5	....	....	333	338	251	125	125	92
Kansas	195	....	30	234	17	476	471	465	1,694,910	5,039	4,778	+ 5.5	17,725,692	17,022,811	7	....	2	86	95	90	....	24	786	900	1,188	247	242	245
Kentucky	131	....	23	97	1	252	251	320	185,620	2,931	3,782	— 22.5	2,309,276	3,149,413	....	....	1	1	2	10	....	2	44	56	89	142	144	180
Louisiana	176	17	48	128	....	369	369	359	2,732,125	3,638	3,831	— 5.0	27,972,877	29,289,485	3	4	1	42	50	31	18	8	482	539	537	305	318	325
North Louisiana	74	....	35	58	....	167	177	167	612,201	1,450	1,543	— 6.0	5,331,593	5,445,656	2	....	....	24	26	15	....	2	220	237	212	56	67	50
South Louisiana	102	17	13	70	....	202	192	192	2,119,924	2,188	2,288	— 4.4	22,641,284	23,843,829	1	4	1	18	24	16	18	6	262	302	325	249	251	275
* Gulf of Mexico	22	4	4	9	....	39	34	51	427,591	505	474	+ 6.5	5,173,068	4,867,623	....	....	....	2	2	....	2	1	34	37	36	60	56	58
Michigan	25	....	5	41	....	71	81	48	249,882	852	596	+ 43.0	3,109,570	1,866,492	....	....	....	26	26	9	....	3	242	254	167	120	112	115
Mississippi	23	2	6	48	....	79	49	76	695,174	708	669	+ 5.8	6,944,981	6,291,843	3	....	....	25	28	20	....	1	229	250	252	66	62	77
Missouri	....	....	....	1	....	1	2	....	2,500	13	14	— 7.2	31,861	12,901	....	....	....	1	1	....	....	....	4	4	11	1	1	3
Montana	12	....	1	25	1	39	35	44	172,264	324	342	— 5.3	1,570,996	1,639,710	1	....	....	22	23	10	....	4	129	143	110	31	24	42
Nebraska	25	....	....	40	....	65	73	70	316,048	926	825	+ 12.2	5,101,070	4,872,812	3	....	....	21	24	28	....	1	406	435	377	27	30	25
New Mexico	78	....	34	32	....	144	155	167	772,836	1,817	1,819	— 0.1	8,997,968	7,580,624	7	....	....	17	24	62	....	36	246	344	279	134	158	173
Southeast	67	....	1	27	....	95	92	108	492,793	1,199	1,015	+ 18.1	6,082,654	4,691,142	7	....	....	13	20	45	....	11	184	240	189	84	93	98
Northwest	11	....	33	5	....	49	63	59	280,043	618	804	— 23.1	2,915,314	2,889,482	....	....	....	4	4	17	....	25	62	104	90	50	65	75
New York	18	....	6	2	8	34	34	19	44,162	336	273	+ 23.1	524,822	474,850	....	....	....	....	....	....	....	....	....	....	....	25	25	25
North Dakota	11	....	....	9	....	20	16	51	121,563	273	433	— 37.0	1,715,525	2,741,670	....	....	....	5	5	7	....	....	64	71	83	12	12	25
Ohio	60	....	29	18	....	107	92	121	263,031	1,045	1,085	— 3.7	2,557,693	2,761,713	....	....	2	4	6	3	....	9	41	53	41	131	138	210
Oklahoma	195	7	29	123	30	384	337	337	1,364,312	4,537	5,192	— 12.6	16,971,324	19,137,906	10	2	5	29	46	53	9	36	348	446	729	443	469	495
Pennsylvania	16	....	15	9	10	50	48	62	157,650	838	695	+ 20.6	2,352,980	2,148,815	....	....	1	3	4	....	....	8	21	29	24	47	50	56
South Dakota	....	....	....	....	....	....	....	3	....	18	23	— 21.7	127,687	168,360	....	....	....	....	....	....	....	....	8	8	14	....	1	5
Tennessee	....	....	....	3	....	3	11	....	3,157	93	107	— 13.1	78,767	100,422	....	....	....	1	1	3	....	3	51	57	57	20	23	25
Texas	598	21	104	437	26	1,186	1,190	1,403	7,089,401	15,050	17,597	— 14.5	68,206,484	77,636,405	22	2	5	252	281	166	42	68	3,024	3,300	3,825	852	885	971
Dist. 1: South Central	39	1	1	43	1	85	97	96	242,428	1,117	979	+ 14.1	2,891,315	2,587,789	1	....	....	28	29	4	1	3	314	322	308	38	35	38
Dist. 2: Middle Gulf	8	5	14	21	....	48	43	49	366,217	738	786	— 6.1	5,007,267	4,910,719	....	2	....	12	14	8	13	7	208	236	283	56	65	58
Dist. 3: Upper Gulf	30	11	2	55	....	98	79	107	2,152,861	1,116	1,190	— 6.2	9,454,385	8,439,430	1	....	....	33	34	10	16	5	265	296	287	93	90	96
* Gulf of Mexico	....	....	....	4	....	4	1	....	39,659	10	5	+100.0	97,783	49,112	....	....	....	4	4	....	....	....	7	7	4	2	1	....
Dist. 4: Lower Gulf-S.W.	36	3	18	50	....	107	75	100	648,111	1,055	1,308	— 19.4	5,887,046	7,115,371	1	....	1	41	43	11	9	16	317	353	410	88	85	64
*Gulf of Mexico	....	....	....	....	....	....	....	....	....	....	1	....	....	500	....	....	....	....	....	....	....	....	....	....	1	....	....	....
Dist. 5: East Central	2	....	2	10	....	14	20	22	60,198	211	162	+ 30.2	1,039,729	874,843	....	....	....	6	6	2	1	4	105	112	77	14	16	8
Dist. 6: Northeast	35	1	9	29	....	74	77	77	410,498	879	840	+ 4.6	4,716,538	4,628,080	1	....	2	18	21	7	2	5	175	189	182	61	76	47
Dist. 7-B: North Central	80	....	12	74	2	168	165	171	531,352	2,179	2,392	— 8.9	6,520,638	7,729,310	11	....	1	38	50	54	....	11	584	649	794	82	84	92
Dist. 7-C: West Central	34	....	3	21	1	59	58	51	261,656	777	749	+ 3.7	3,206,031	3,218,196	2	....	....	17	19	17	....	6	205	228	251	60	67	71
Dist. 8: West	152	....	10	37	3	202	235	302	1,429,550	2,994	4,445	— 32.7	16,982,771	22,799,109	5	....	1	18	24	41	....	6	341	388	538	169	175	250
Dist. 9: North	135	....	16	80	19	250	259	320	663,422	2,871	3,497	— 17.9	7,528,032	9,643,335	....	....	....	36	36	12	....	1	432	445	539	128	127	157
Dist. 10: Panhandle	47	....	17	17	....	81	82	108	323,108	1,113	1,249	— 10.9	4,972,732	5,690,223	....	....	....	5	5	....	....	4	78	82	156	63	65	90
Utah	6	....	3	10	....	19	17	32	92,411	210	291	— 27.8	1,191,454	1,623,988	....	....	1	8	9	2	....	9	70	81	84	34	34	30
Washington	....	....	....	1	....	1	1	1	4,137	5	4	+ 25.0	26,206	31,928	....	....	....	1	1	....	....	....	4	4	4	2	1	1
West Virginia	27	....	74	12	....	113	78	70	292,216	1,016	783	+ 29.8	2,581,364	2,009,755	....	....	....	....	....	....	....	....	....	....	1	175	155	140
Wyoming	41	....	4	57	1	103	130	110	516,335	1,038	898	+ 15.6	5,238,364	4,687,227	2	....	1	34	37	19	1	9	321	350	350	47	63	78
Others	....	....	....	4	....	4	2	2	18,926	31	22	+ 40.9	137,906	124,985	....	....	....	4	4	....	....	....	29	29	15	13	10	4
Total United States	1,930	47	444	1,580	96	4,097	4,001	4,266	18,684,726	46,778	50,179	— 6.8	194,583,142	206,199,165	64	8	23	693	788	564	71	246	8,222	9,103	9,907	3,511	3,620	3,894
Total Western Canada	116	....	19	46	....	181	186	233	970,305	2,437	2,516	— 3.1	13,354,136	12,642,310	....	....	....	....	....	....	....	....	....	....	....	181	160	249

* Gulf of Mexico wells are included in their respective district total. † Revised.

...in difficult areas

On the surface, tellurometers accurate to within inches over a fifty-mile traverse are visible indicators of GSI's new look at refraction shooting.

Looking deeper, recently developed refraction interpretation techniques, special refraction instruments and seismometers are giving GSI clients subsurface data in areas where it was unobtainable in the past.

If you have prospects which refuse to yield deep data through the use of reflection shooting our new look at refraction will interest you.

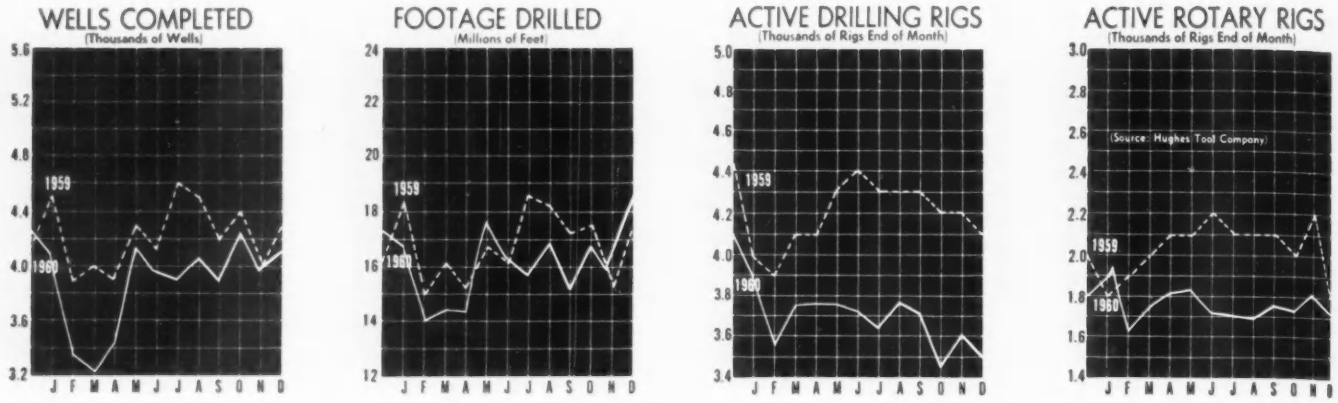
For additional details, write ....

GEOPHYSICAL SERVICE INC.

900 EXCHANGE BANK BLDG. • DALLAS 35, TEXAS

A TEXAS INSTRUMENTS COMPANY

Drilling Activities.



U.S. rig activity at 19-year low

By WORLD OIL Staff

U.S. OPERATORS reported 46,778 new well completions during 1960 down 3,401 or 6.8 percent from the previous year—and 11,340 wells less than the peak year of 1956.

The four-year decline in annual well completions dropped the 1960 total to the lowest level since 1952, when 46,509 new completions were reported. Last year's drilling picture in brief:

Footage drilled totaled 194,600,000 feet, down 5.6 percent from the 206,200,000 feet drilled during 1959—for the lowest total in nine years.

Total wildcats decreased 8.1 percent, from 9,907 in 1959 to 9,103 last year.

New crude oil completions decreased 12.9 percent, from 25,532 in 1959 to 22,233 last year. This was the smallest total since 1949, when 21,415 wells were completed.

New natural gas completions increased 7.6 percent, from 4,070 in 1959 to the highest annual total in history—4,379.

At year's end, 3,511 rigs were reported operating in the United States, down 109 from November—and 383 less than were reported on December 31, 1959. The December 31, 1960 total was the smallest since 2,797 rigs were reported operating at year's end during the war year of 1942.

Total Drilling in United States

ITEM	December 1960	November 1960	YEAR 1960	YEAR †1959	% Diff.
New Wells Completed	**4,097**	**4,001**	**46,778**	**50,179**	**— 6.8**
Oil	1,930	1,894	22,233	25,532	—12.9
Distillate	47	45	750	800	— 6.3
Gas	444	408	4,379	4,070	+ 7.6
Dry	1,580	1,524	18,185	18,669	— 2.6
Service	96	130	1,231	1,108	+11.1
Footage Drilled, Million Feet	**18.7**	**15.9**	**194.6**	**206.2**	**— 5.6**
***Active Rigs, End of Period**	**3,511**	**3,621**	**3,511**	**3,894**	**— 9.8**

* Includes wells drilling, rigging up, and temporarily shut down. †Revised.

Wildcats Completed in United States

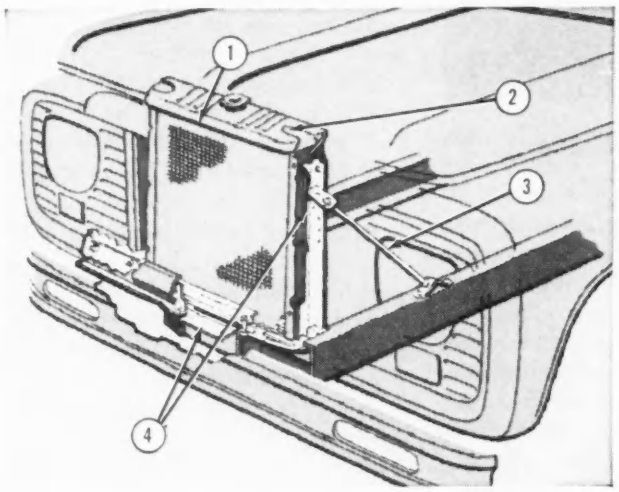
ITEM	December 1960	November 1960	YEAR 1960	YEAR 1959	% Diff.
New Field Discoveries:	**95**	**52**	**881**	**1,079**	**—18.4**
Oil	64	38	564	713	—20.9
Distillate	8	4	71	85	—16.5
Gas	23	10	246	281	—12.5
Dry Wildcats	**693**	**661**	**8,222**	**8,828**	**— 6.9**
Total Wildcats	**788**	**713**	**9,103**	**9,907**	**— 8.1**
Percent Productive	**12.1**	**7.3**	**9.7**	**10.9**	.....
Percent Dry	**87.9**	**92.7**	**90.3**	**89.1**	.....

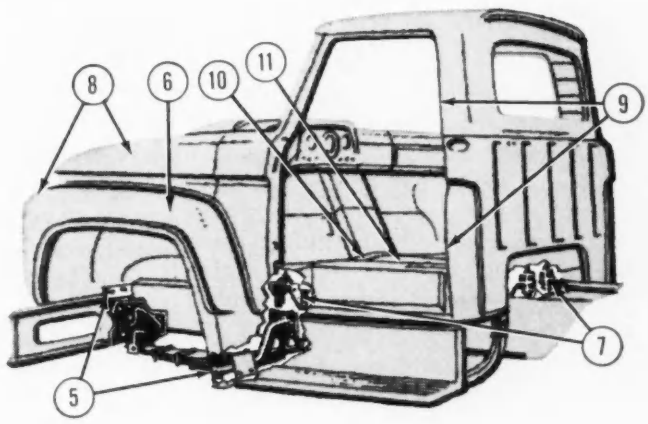
Drilling in Western Canada

ITEM	December 1960	November 1960	YEAR 1960	YEAR †1959	% Diff.
New Wells Completed	**181**	**186**	**2,437**	**2,516**	**— 3.1**
Oil	116	123	1,453	1,417	+ 2.5
Gas	19	20	299	312	— 4.2
Dry	46	42	641	753	—14.9
Service	.....	1	44	34	+29.4
Footage Drilled, Million Feet	**1.0**	**1.0**	**13.4**	**12.6**	**+ 6.3**
***Active Rigs, End of Period**	**181**	**160**	**181**	**249**	**—27.4**

* Includes wells drilling, rigging up, and temporarily shut down. † Revised.

SAVE WITH NEW HEAVY-DUTY CONSTRUCTION THAT DOUBLES CAB, SHEET METAL AND RADIATOR LIFE





(1) **Save with Ford's exclusive "lock-seam" radiator construction** that doubles the solder area at key seams for greatly increased strength and longer radiator life.

(2) **Save with heavier-gauge metal on radiator tank and header.** Upper and lower tanks and header have thicker walls to resist vibration, jolts and corrosion for greater reliability.

(3) **Save with independent radiator mountings,** separate from front-end sheet metal. This means that road shocks, vibrations and shakes are not transmitted to the radiator through sheet metal . . . tanks, tubes and connections last longer, require less maintenance.

(4) **Save with "horse collar" mounting** seated on rubber pad for extended radiator life. This new mounting on resilient rubber at the center of frame cross member soaks up any frame flexing . . . cuts wear and tear on entire cooling system.

(5) **Save with independent fender mountings.** Fenders are bolted to a rubber-cushioned transverse bracket at the front and a frame-mounted bracket at the rear. This mounting, independent of both cab and radiator, eliminates stress transfers for greatly increased fender life.

(6) **Save with removable fenders.** The quick and easy removal of only 8 bolts per fender provides faster service accessibility to the engine area, saving valuable maintenance time.

(7) **Save with new 3-point cab mounting system** for greater cab durability. Two outboard front mounts plus a centered "twin" rear mount provide a triangular system that holds the cab stationary while allowing the frame to move independently . . . reducing strain on the cab.

(8) **Save with 42% heavier-gauge sheet metal** in fenders, hood, cab floor pan and toeboard for greater strength, greater durability.

(9) **Save with stronger cab construction.** New full-length door pillar reinforcements provide increased cab rigidity, stamina.

(10) **Save with a more solid foundation.** 42% thicker sheet metal is used in the integral floor pan and toeboard, this with added floor reinforcements gives a stronger base for longer cab life.

(11) **Save with new transmission access panel** to cut transmission service time.

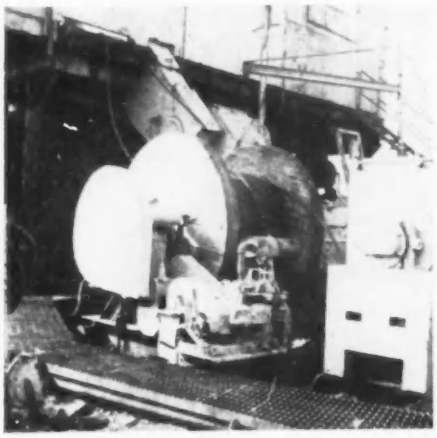
FORD TRUCKS COST LESS

YOUR FORD DEALER'S "CERTIFIED ECONOMY BOOK" PROVES IT FOR SURE...

FORD DIVISION, Ford Motor Company

Practical Operating Hints

These **How-To-Do-It** Ideas Can Save You Money



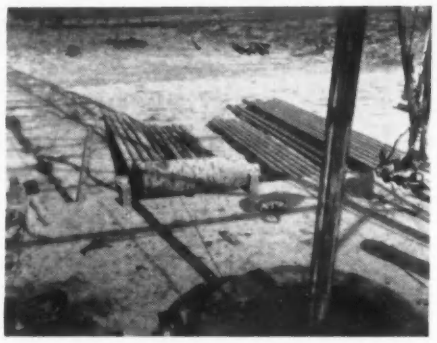
Electric Motor Reels In Drilling Lines at the Rig

One drilling rig operator has solved the problem of reeling and unreeling drilling line from heavy, bulky, reels. A skid base provides an adequate mount for the reel so that it can be turned on the pipe that is inserted through its center. By extending the skid base slightly, a small, general purpose horsepower engine has been mounted to provide rotation.

The engine enables the operator to pull his line through and reel it up with little or no strain when rigging-down and moving the rig. When on location and during normal operations, the engine can be used to turn the reel and release more line when the blocks are on the floor and the line is being cut off.

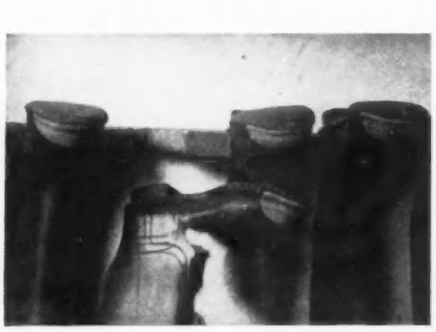
Scrap Lumber Sheath Protects Edges on Cutter

Make a sheath from scrap lumber to protect the cutting edges on a weed cutter. The sheath illustrated was made from scrap lumber. The bottoms and sides were fitted so the blade would slide in easily. The end of the sheath was closed and an additional brace was placed on top. The handle of the blade may be tied to this brace to prevent the sheath from coming off while being carried in the gang truck.



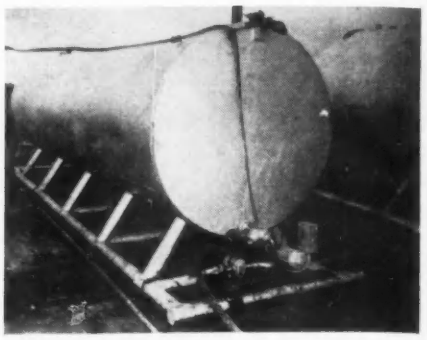
Large Roller Facilitates Moving of Drill Pipe

Where it is necessary to handle drill pipe in singles, a roller made from big-inch pipe with bearings on the hubs will make it easy to lay down the drill pipe. The pipe is 14 inches in diameter and uses the hub and axle from the truck to make it spin easily. When the pipe is being layed down each joint is slid out between two joints on the pipe rack and the large, roller makes the work easy.



Boot Drying Rack Made From Old Lumber

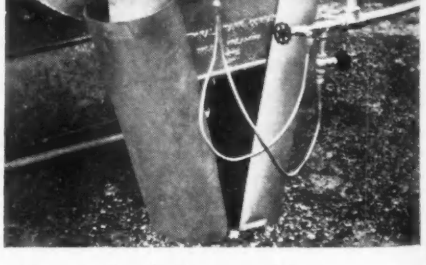
When the roustabout gang finishes a dirty job and boots must be dried, do as this illustration indicates. Notches have been cut in a two by four piece of lumber long enough to support all boots. Notches should be slightly smaller than the boot at the heel. Boots are wedged in place and hang upside down until needed for the next job.



Construct Simple Support To Facilitate Loading

Transportation costs are reduced by minimizing the weight load. The small gear pump is installed in the base of the fuel tank. When the engine-man wants to fill the day tanks on the engines, he comes by and punches the "on" button and fills them up—usually at the beginning of each tour.

Instead of having to carry a high scaffold to set the tanks on, a simple support made of 2½-inch boiler fuel material is used to hold the tank up off of the ground and facilitate loading. The pumping unit is mounted on the front end of the support and when it is spotted at the rig it is only necessary to connect up the fuel hose and plug in the electric motor.



Discarded Stove Pipe Keeps Heater Fired

This Gulf Coast operator has installed two split pieces of stove pipe on each side of the heater fire box to prevent wind from blowing out the fire. The sections are easily inserted in the ground and serve as an excellent wind shield.

Technical-Operating Details Of . . .

Production operations in Algeria's Hassi Messaoud field

French operators use three rigs, four phase mud program on each hole. Permanent type well completions, special packer fluids cut workover costs

By R. J. Rousseau
Petroleum Engineer
Compagnie Francaise des
Petroles, Algiers, Algeria

FRENCH OPERATORS have encountered a number of unusual drilling and producing problems during development of Hassi Messaoud field. To economically resolve these difficulties, which include lost circulation, high pressure salt water flows, asphaltic tubing deposits, bottom hole sediments, ineffective stimulation treatments and involved workover jobs, the operators are using:

- Three rigs to complete a single well
- Four-phase mud program on each hole
- Permanent type well completions
- Calcium nitrate packer fluid
- Experimental fracturing program.

Hassi Messaoud field is located in the Sahara desert, about 450 miles southeast of Algiers. The field is being developed by Compagnie Francaise des Petroles (Algeria) and Societe Nationale de Recherches et d'Exploitation des Petroles en Algerie.

Pay characteristics. The productive zone at Hassi Messaoud is a Cambro-Ordovician sandstone which can be broken down into three more or less productive components on the basis of permeability, intergranular cementing and water saturation.

The uppermost, or Q zone, varies to 140 feet in thickness, and is a low-permeability fine-grained siliceous cement sandstone. It has been found in very few of the wells drilled to date.

The middle or R_1 zone is the main productive horizon and is a fine-grained, fractured siliceous cement, quartz sandstone. It varies from 80 to 330 feet in thickness and has been absent in only two wells. Average permeabilities vary from less than 1 md to 150 md. Intergranular permeabilities and porosities usually are low.

The lower, or r_1 zone, is a low-permeability high-water saturation fine-grained quartzitic sandstone having an argillaceous cementing material. Under normal conditions, the zone contributes little to a well's overall productivity. It also is doubtful whether stimulation techniques would improve this situation. A type section for the field is shown in Figure 1.

The top of the productive zone is found from 10,662-10,990 feet. Original static bottom-hole pressure averaged 6,832 psi. Oil is about 45 gravity and is undersaturated at reservoir conditions. Bubble point of the reservoir fluid varies from 2,280 psi to 2,700 psi measured at original reservoir temperature of 248° F.

The productive trend is approximately 31 miles long and 28 miles wide. Water limits production to the east and north and low permeability limits productivity to the south and west. Areal distribution of permeable zones is extremely heterogeneous. Because existing wells have been widely spaced, only broad permeability trends have been defined and extreme exceptions can be found within this area.

Drilling program. Three rigs are used to drill and complete an individual well. A light rig spuds in, sets surface casing and drills ahead to about 1,950 feet. A 12,000-foot rig then is moved on location and drilling is resumed. After intermediate and production casing has been set, this rig is moved off and an intermediate type rig is used to drill out cement, core the producing horizon, set liner (if one is run) and complete the well.

The light rig is used initially because of a severe lost-circulation problem in the zones immediately above the setting-point of the surface casing. Use of a heavy rig during this period would be expensive; hence, a light rig is used to cut costs. It has also been found that wells are more easily contracted on a dollars-per-foot basis, once this depth has been reached.

The high hook-loads imposed by running and setting 9⅝-inch casing

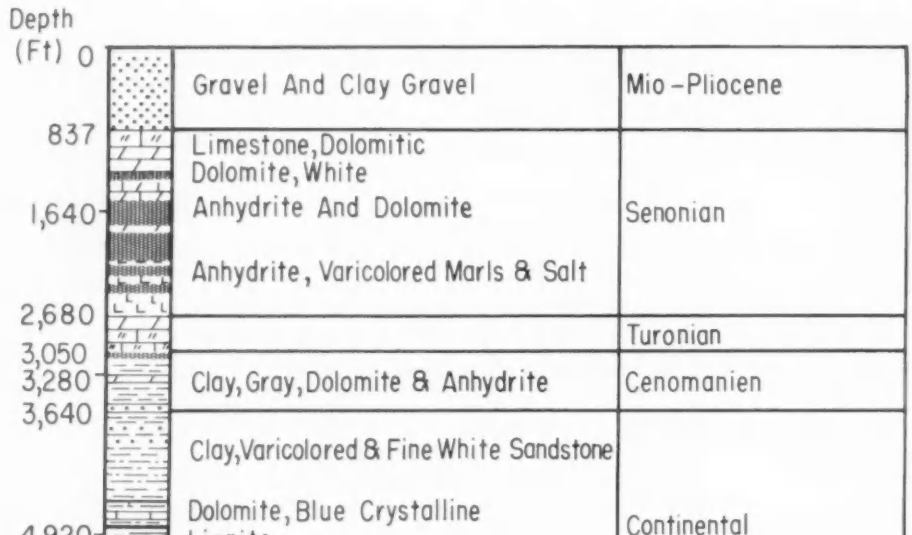


FIGURE 1—This type columnar section for the Hassi Messaoud field was taken from the discovery well. Arrow indicates Cambro-Ordovician pay.

to 8,200 feet and 7-inch casing to 11,000 feet, requires use of a heavy rig. Also, tripping of 5-inch drill pipe used above the production casing setting-depth requires a high-capacity rig. This interval is conveniently contracted on a footage basis.

Use of the intermediate rig for coring and completion frees the heavier contract rig from another unpredictable operating period. It has also been found that crews continuously coring and completing wells become specialists and do a better job.

It should be pointed out that this program is not rigid and exceptions are frequently made if conditions warrant.

Mud program. The drilling mud program for a single well is divided into sections as follows:

1. Fresh water base mud phase
2. Salt base mud phase
3. High density mud phase (salt base)
4. Intermediate density mud phase (fresh water or oil base).

Fresh water base mud is used to drill surface hole, set surface casing at about 820-feet and to drill ahead to approximately 1,950 feet.

Massive salt and anhydrite beds lying below 1,950 feet requires use of a salt base drilling fluid. High mud weights are not advisable while drilling this section due to possible lost circulation in incompetent shales found between 1,950 feet and 7,850 feet. The salt base mud also is used during setting of the intermediate string of 9⅝-inch casing at 8,200-8,500 feet.

After drilling out cement in the intermediate string, the salt base mud system is weighted to at least 17.5 ppg to contain a high-pressure water zone between 8,500-9,000 feet. This zone has been found to contain saturated calcium chloride water at pressures to 8,250 psi.

The high weight salt mud system is maintained until the 7-inch production string has been set and cemented. Serious lost circulation problems occur due to fracturing of incompetent shales by the high density fluid. Circulation normally is regained by setting of cement plugs.

To minimize damage to the productive zone, the high-density salt base mud is broken over to 13.5 ppg fresh water or oil base mud prior to completion. Water loss is controlled with carboxymethylcellulose.

The change-over is effected during drilling of the cement in the production string. This mud is maintained to completion and is sometimes used as a packer fluid. Inverted, water-in-oil emulsion muds have been used during this phase.

Casing program. In areas where severe lost circulation occurs at shallow depths, 18-inch conductor pipe is required for control. However, under normal conditions, 13⅜-inch surface casing set in 17⅜-inch hole and cemented to surface provides adequate protection.

A 9⅝-inch intermediate string is set in 12¼-inch hole to protect the incomplete formations above the high pressure water zone. The string is cemented in two stages to protect a mildly brackish artesian water zone at 3,300 feet. The lower stage is cemented with ordinary cement.

The 7-inch production string isolates the high pressure water zone and permits use of an intermediate weight mud during coring and com-

pletion operations. Pipe is set in 8½-inch hole and is cemented from the casing shoe, which is set on top of the productive zone, to 500 feet above the 9⅝-inch casing shoe. Retarded cement is used.

If conditions warrant, liners may be run below the production string. Principal reasons for setting liners include:

Cementing 7-inch casing under lost circulation conditions. This situation is caused by an incompetent shale zone approximately 1,150 feet above the producing horizon. Under these conditions, protection afforded by the production string is greatly reduced and a liner is desirable. Although liners have not yet been set under these conditions, they are being considered.

Penetration of the aquifer. The aquifer has been penetrated by two productive wells to date. Liners have been set and cemented in these wells to permit selective withdrawals from the productive zone. In this application, the liner is usually set from total depth to a point 300-450 feet above the oil string casing shoe.

Production casing is set high. In this case, a liner is necessary to protect the shales overlying the productive horizon during well stimulation treatments prior to completion. The liner is set from total depth to 300-500 feet above the casing shoe.

Completion procedures. Most wells are completed using the permanent type completion method. A drillable packer-retainer is set on wireline. The tubing string, equipped with a landing nipple above and below a circulating valve, is run and anchored in the packer. In wells which are completed barefoot, water is circulated to the production packer through the circulating valve or around the stinger prior to seating the sealing nipple in the packer.

The christmas tree is flanged up and the well allowed to clean up. Variations from this include spotting special packer-fluids, one or two packerless completions of observation wells and perforated liner completions. A typical surface hook-up is shown in Figure 2.

Since production is not prorated, withdrawals are permissible under maximum efficient rates. The areal heterogeneity of the permeability distribution has resulted in a wide variation in individual well productivities.

Wells have been categorized as large, intermediate and small producers. Due to the influence of native fractures on individual well productivity, core analysis alone cannot be reliably employed to forecast productivity. Hence, a hook-wall type drill-stem test is normally run over the productive interval if anhydrous production is indicated.

This test serves as an indication of the well's ultimate productivity and is the basis for tubing size selection. Friction losses in the 10,500-foot tubing strings have necessitated use of tubing diameters up to 4¼ inches for flow rates in excess of 190 bph.

On the other hand, an intermediate well selected for large-volume fracturing will require a tubing size of at least 3½ inches to permit high injection rates. Small wells have been found to respond poorly to stimulation treatments and have been tubed with 2⅞-inch tubing. Annular production and injection has been considered, but existing casing designs have prevented their use so far.

Packer fluids. Crude oil, mud and weighted calcium nitrate solution have been used as annular fluids. Crude was used initially, but proved impractical if tubing leaks developed and pressured the oil string.

Weighted drilling mud then was used, but settling out of the weight material stuck pipe and impeded recovery of tubing during workovers. To solve the problem, a high density (13.5 ppg) calcium nitrate solution was developed and now is undergoing field tests.

Production equipment. Production is brought into a central separation and storage plant where three stage gas separation is effected. The separation plant was designed to handle 58 million barrels per year and is semi-automated. Figures 3 and 4 show portions of the central installation.

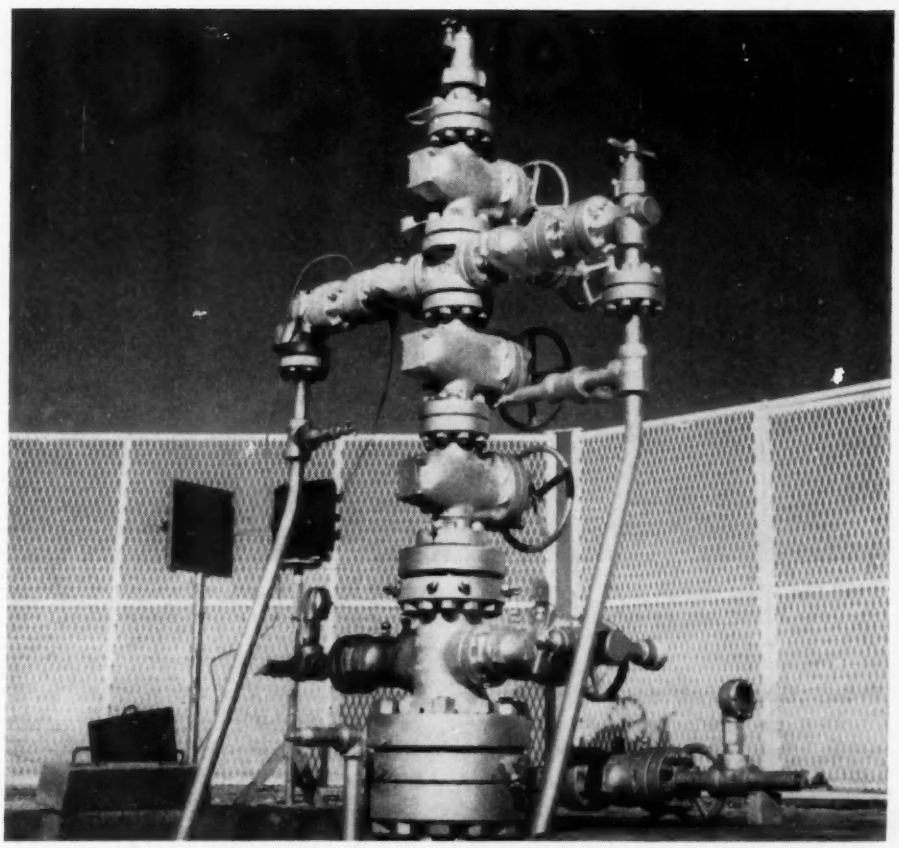


FIGURE 2—Here is a typical surface well hook-up in Hassi Messaoud field. Most wells are permanent type completions.

FIGURE 3—Production manifold is welded, utilizes three-way plug valves for control.

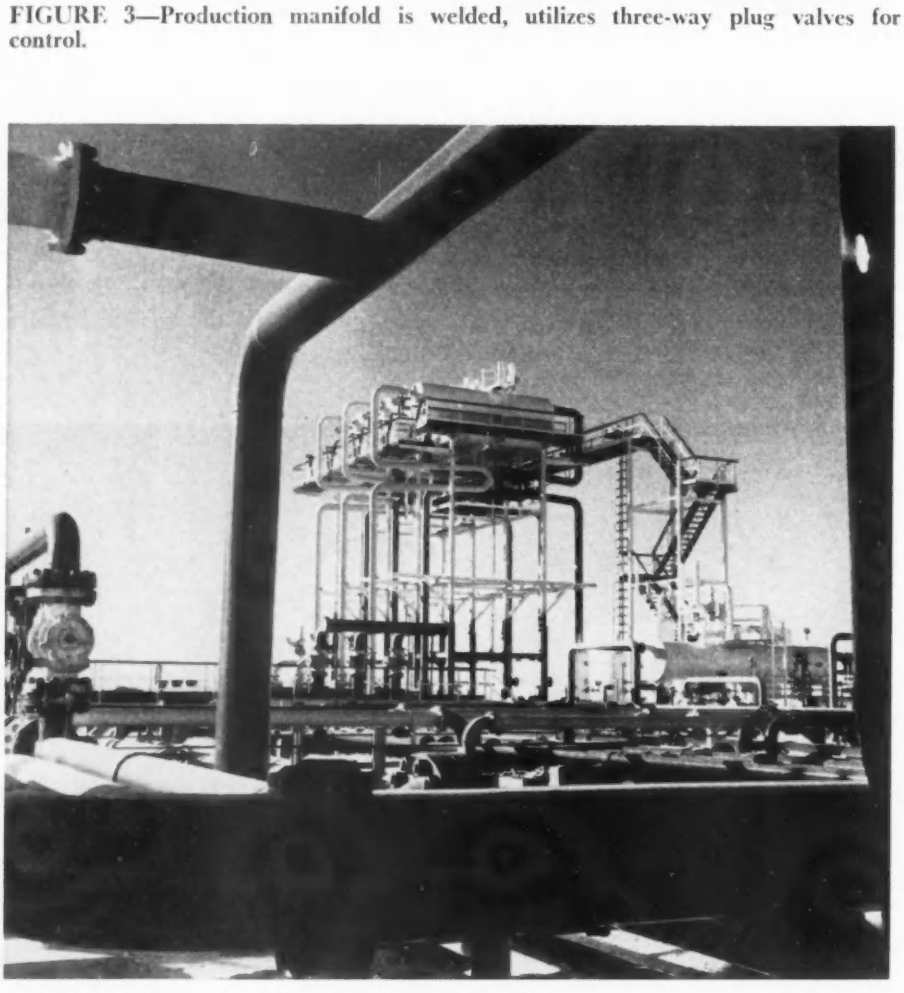


FIGURE 4—Central tank battery is equipped for three-stage separation of production. Photo shows elevated horizontal low pressure separator installation.

Production problems. Major production problems include tubing deposits, ineffective well stimulation treatments and bottom-hole sediments.

Tubing deposits are asphaltic, vary from well to well and occur rarely in other areas. Pressure, temperature, gas coming out of solution and possibly salt-water coming from behind the production string are all influencing factors. To date, the deposits have been controlled by both mechanical and chemical means.

Four formation fracturing jobs (two on small producers, two on intermediate producers) have been attempted to date. All were similar type treatments using gelled water as the carrier and 20-40 mesh Sahara sand as the propping agent. Test results were inconclusive, and a further fracturing campaign is currently underway.

Several pump-in experiments were conducted prior to actual fracturing operations. Surface pressures of 5,000-7,500 psi at 6-8 bpm rates were obtained during both pump-in experiments and actual fracture jobs.

Two of the wells fractured were open-hole completions and one was on a perforated-liner completion that had penetrated the aquifer. The last was performed on a well in which 7-inch casing was set in the shale above the producing zone. The well then had been completed with a liner. Only one of the four wells (an intermediate producer) showed significant increase in productivity.

Surveys have indicated a considerable fill-up of open hole after a period of steady production. Samples of the sediments show them to be composed of mud weighting material, sand grains and individual pieces of sandstone. Crystalline salt also has been recovered in some wells.

Control methods attempted so far include high flow-rates and bailing with a thru-tubing bailer. However, neither technique was successful.

Origin of the sediments has prompted much discussion. One view is that they are the result of mud weight material settling out at the time of completion. Another is that they represent a part of the effluent from the native formation fractures.

Open hole above the sediments possibly contributes the greater part of the well's productivity and their elimination may be unnecessary. The problem is unsolved.

Transportation. Crude was transported originally by a small-diameter pipe line to Touggourt, thence by rail to the Mediterranean port of Philippeville. This has been replaced by a 24-inch pipe line system from the field directly to the Mediterranean port of Bougie in Northern Algeria. This 24-inch pipe line was placed in continuous service early in December 1959.

ACKNOWLEDGMENT

The author extends his thanks to the management of Compagnie Francaise des Petroles (Algeria) for their permission to publish this article.

Oil basins surround the Arctic Ocean

Alaska, Canadian Islands, Greenland and Spitsbergen have prospective areas related to ancient mobile belts; precise geology and geophysics needed

By Leonid Smirnow
Consulting Geologist
New York City

EXPLORATION FOR OIL in the virtually untouched far north is under way. Commercial oil production has started in Alaska. Strong interest has been shown in leasing in the Canadian Arctic islands. American Overseas Petroleum Ltd., and Royal Dutch Shell conducted geological investigations of Spitsbergen during the summer of 1960. Despite the current worldwide crude oil glut, oil exploration in the Arctic will accelerate in coming years and will probably include northern Greenland and other remote Arctic regions not heretofore seriously considered.

With readily feasible adaptation of current technology, oil operations in the Arctic can be carried out. Valuable experience with the effect of extremely cold temperatures on operating personnel was acquired in Naval Petroleum Reserve 4 in northern Alaska during World War II and more has been acquired since then. The Norman Wells field in extreme northwest Canada has been producing oil for 40 years. The Military Sea Transportation Service has been operating ice-breaker tankers for several years to supply far northern military bases. Much larger tankers of similar design are envisioned for the future should major oil sources be developed in partially ice-bound Arctic regions. Permafrost in considerable depth is a problem affecting seismograph reflections, oil and gas production and other operating phases, but it is not believed to be a major obstacle.

Military and bunker fuel needs, combined with the development of the Arctic as the world's commercial air-travel crossroads as exemplified by the rapidly developing Frobisher Bay, Baffin Land airport, and the need of these regions for local sources of fuel are market factors indicative of a steadily increasing oil exploration effort in the Arctic. Furthermore, several prospective areas (e.g., Spitsbergen) are not too remote from Western European markets.

THE ARCTIC MASS

The "top of the world" represents an ancient platform area, evolving from Proterozoic (late pre-Cambrian) time. Recent soundings from stations located on the polar ice cap have shown that a narrow ridge about 10,000 feet high crosses the Arctic Ocean floor parallel to the European continental slope from the New Siberian Islands to Ellesmere Land. The top of this submerged mountain chain (called Lomonosov Ridge) is only about 2,700 feet below sea level.

Although its exact nature is unknown, this ridge could be an old mobile belt of Proterozoic or Caledonian age. Other interpretations on the nature of this ridge indicate that it may be connected with intense vertical dislocations of Laramie time, or perhaps it represents a more recent isostatic adjustment to the asymmetrical structure of the Atlantic and Pacific sides of the Arctic.

Mobile belts on the Atlantic side—e.g., the Ellesmere Land-northern Greenland-Spitsbergen - Scandinavia belt—developed in Caledonian (late Silurian-early Devonian) times and have become relatively stable since then. The Novaya Zemlya-Taymir mobile belt reached relative stability after Hercynian (Permo-Carboniferous) time. On the Pacific side, the Verkhoyansk-North American Pacific mobile belts continued their development through Mesozoic into Tertiary time.

Another submarine ridge north of Point Barrow, Alaska, extends beneath the Arctic Ocean toward the pole. Considerable research is being done to chart the Arctic Ocean floor.

Local and regional features are so strongly interrelated that the Arctic may be analyzed as a geologic unit. Movements of the Arctic Mass (or platform) caused many so-called "marine transgressions" from the north into adjacent areas in North America and Eurasia.

Cold climatic conditions appear to date only to relatively recent geologic time. Evaporite deposits and reefs dot the sedimentary column in virtually all sedimentary basins ringing the Arctic Ocean. Evaporites cap the thick, late Proterozoic sedimentary column in the Western Franklin depression of Victoria Island.

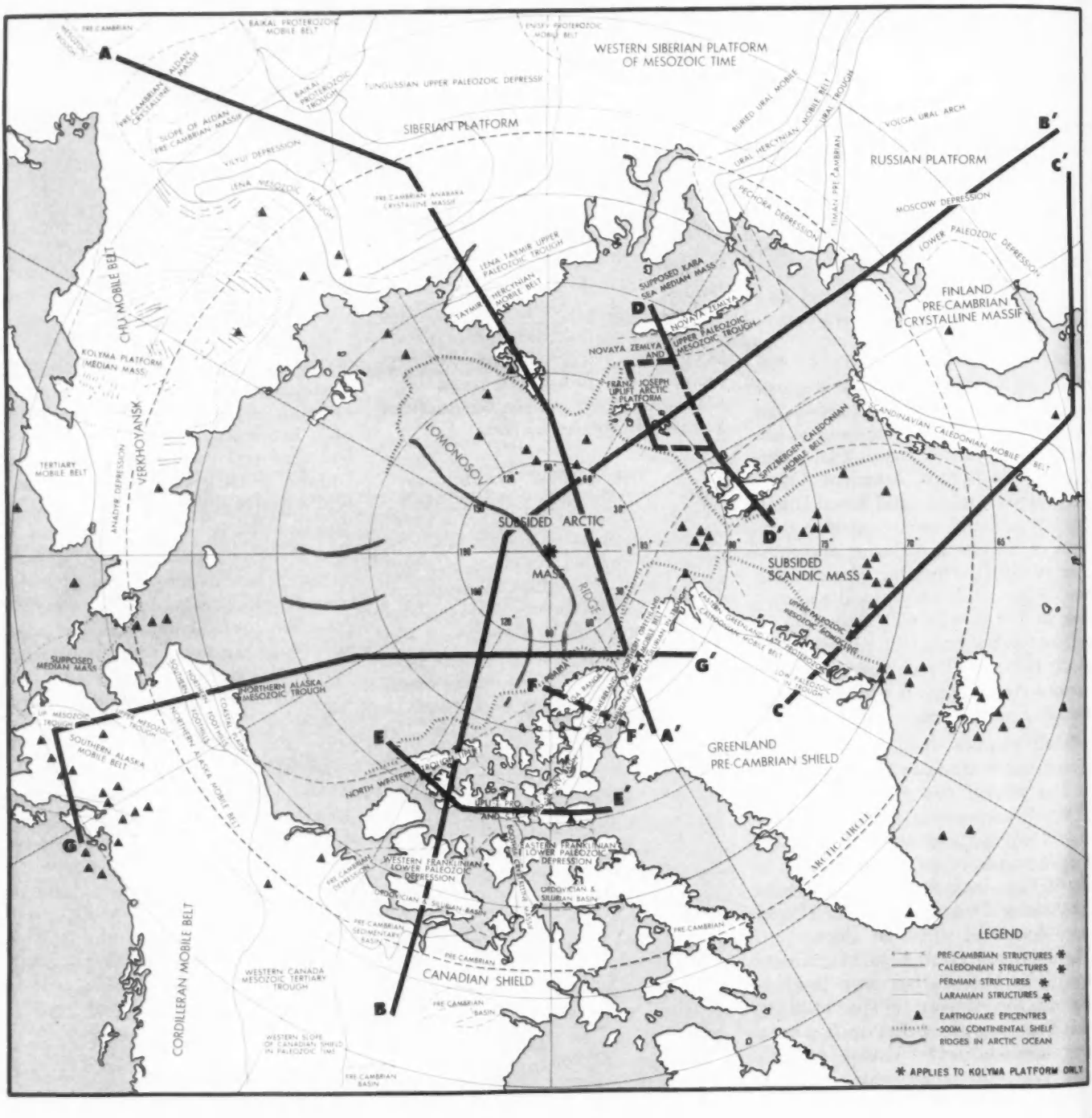
The trough of the northern branch of the Ellesmere Land mobile belt shows evidences of Carboniferous-age reefs. The upper Devonian section of eastern Greenland has an evaporite section and transgressive Carboniferous-age reefs. Reefs are also present in Paleozoic formations at the Arctic edge of the Russian platform.

PLATFORMS ADJACENT TO THE ARCTIC MASS

South of the Arctic Ocean are three big platforms or shields, the Canadian-Greenland Shield, Russian-Siberian Platform and a possible Scandic platform. Large, oil-prospective sedimentary basins cover portions of these platforms in the Arctic. Paleozoic sediments are most common, with Mesozoic strata occurring in many places also.

The Greenland Shield is part of the Canadian Shield. It was separated from the Baffin Land portion of the Canadian Shield in Tertiary time by the Baffin Bay graben. Owing to the thick ice cap it is not known whether central Greenland

GENERAL STRUCTURE OF THE ARCTIC



has a sedimentary cover. However, in northern Greenland, a lower Paleozoic pre-mountain trough lies in front of the north Greenland mobile belt. In fjords of eastern Greenland, a Paleozoic trough is likewise evident, parallel to the Caledonian mobile belt of eastern Greenland. Sediments here may be similar to those in the Appalachian Basin.

The Russian Platform occupies northeastern Europe. It is bounded on the east by the Ural mobile belt and on the northwest by the Caledonian Mountains of Scandinavia. The Russian Platform coalesces northward with the Arctic Mass of the Barentz Sea and Franz Josef Land area.

The Siberian Platform also lies adjacent to the Arctic Mass, south of the Ural-Novaya Zemlya, Taymir and Verkhoyansk Chucotka geosynclines. The pre-Cambrian Anabara crystalline massif forms the core of the Siberian Platform, covered on the flanks by Paleozoic sediments. A very deep Mesozoic premountain trough in front of the Verkhoyansk and Taymir mobile belts flanks the Siberian Platform on the east and north. The western boundaries of the Siberian Platform are not known, nor

is the boundary of the buried eastern part of the Ural mobile belt.

PROSPECTIVE MEDIAN MASS AREAS

In the Arctic there are some very important median masses within the mobile belts.

The Cook Inlet median mass occupies much of southern Alaska north and east of Anchorage between the Alaska and Pacific ranges. The Cook Inlet median mass includes Kenai Peninsula, the Cooper Basin near the Wrangel Mountains and the Susitna River Basin. This median mass was tilted to the north, causing development of a very deep Mesozoic trough in front of the south side of the Alaska Range. The edge of the median mass is projected along the northern part of the Kenai Peninsula; this fact was the basis for the author's recommendation in 1952 that Kenai may be the most prospective area in Alaska. It is gratifying to note that production has since been found and developed on Kenai.

On the south side of Cook Inlet on the Kenai Peninsula there are open surface folds which may not coincide with structures in depth. Structures on the northern side of Cook Inlet are more complex than those on the south side. Surface structures on the north side are mostly asymmetrical folds, often accompanied by overthrusts. Geophysics, particularly seismic work, should be used in this area to determine the degree of displacement of surface structures in depth.

Spitsbergen median mass. This narrow graben divides two Caledonian branches of the Spitsbergen mobile belt.

The Kara Sea median mass lies inside of the Novaya Zemlya, Ural and Taymir mobile belts. Large gas reserves have been found south of the Kara Sea, hence this median mass should prove to be of large future value in the Soviet Union.

ARCTIC OIL BASINS

A characteristic feature of Arctic oil basins is the existence of evaporites. These are of pre-Cambrian, Cambrian, Ordovician, Silurian, Devonian and Carboniferous ages. In many Arctic basins salt structures have developed.

There are four basic types of oil basins in the Arctic, as follows:

- Basins related to the Arctic Mass
- Basins in troughs on the south side of mobile belts
- Basins on the north flank of major platforms
- Basins formed inside of mobile belts on median masses.

In the first category (i.e., basins related to the Arctic Mass), there are several distinct types:

- Basins connected with pre-mountain troughs
- Basins connected with the edge of the Arctic Mass
- Basins connected with the Arctic Mass itself.

All of these basins have oil potential, but those of the most readily apparent importance are perhaps those on the southern side of mobile belts and those on median masses. The Canadian Arctic islands exemplify the former category and the Cook Inlet area of Alaska exemplifies the latter.

STRUCTURE OF NORTHERN CANADIAN ISLANDS AND GREENLAND

Structural conditions which will govern accumulation of oil and gas in the Canadian Arctic islands, Greenland, and other far northern areas yet undrilled are very complex. Tectonic movements during Proterozoic, Caledonian and Hercynian times, and to a lesser extent during Laramie times, gave rise to complex relationships and trends. As a

This map shows the location of the Canadian Arctic Islands in detail, and their relationship to the Northwest Territories mainland and to Greenland. It is based on a similar map published previously in WORLD OIL.[1]

FIGURE 1—Cross-section A-A′ indicates the relationship of basins in the central part of the Siberian Shield to mobile belts bordering the Russian Arctic, and analogous North American structure. Ellesmere Island's Arctic shore also consists of altered pre-Caledonian rocks. A lower Paleozoic trough lies between the Ellesmere Land mobile belt and the Greenland Shield. Important oil and gas reserves have been found in salt structures in the Vilyui depression in Sibera.

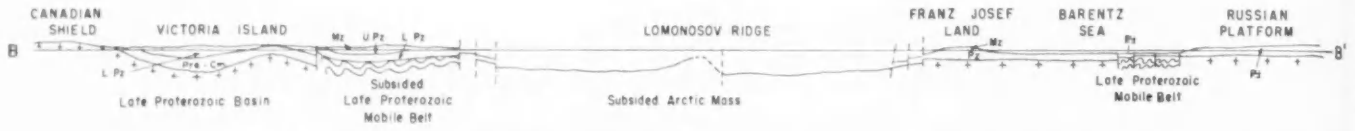


FIGURE 2—Cross-section B-B′ again stresses the similarity of North American and Eurasian Arctic coastal geology. Canadian Shield gives way northward to a late Proterozoic depression on Victoria Island now filled with unaltered late pre-Cambrian sediments capped by lower Paleozoic strata. A buried Proterozoic mobile belt gives way northward to the subsided, drowned Arctic Mass. Lomonosov's Ridge, which may be another Caledonian mobile belt, is prominently shown rising from the Arctic Ocean floor. Franz Josef Land rises from the ocean floor with Devonian, Carboniferous, Permian, and Triassic lying on an uplifted Arctic platform; Carboniferous and Permian limestones are considered oil-prospective.

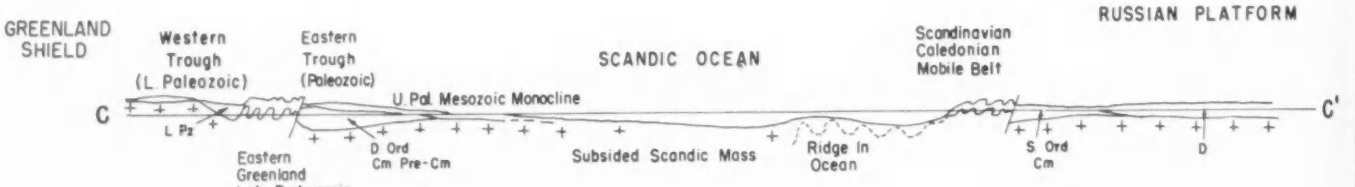


FIGURE 3—Cross-section C-C′ shows relationship between eastern Greenland and Scandinavia. Caledonian mobile belts traversing northern Greenland extend through Spitsbergen to Scandinavia eastward to Russian Platform. Another such belt extends from northern Greenland southward along east coast, and several troughs containing relatively unaltered sediments run parallel to it. One contains about 23,000 feet of Devonian beds. Upper Devonian section is composed of marine sediments and evaporites. Transgressive Carboniferous limestones show reef facies. A thinner Mesozoic section caps these oil-prospective Paleozoic beds. The Baltic Sea depression is omitted from this figure.

result, precise geophysical work will generally be required since structural axes resulting from widely spaced orogenies do not coincide.

Further complicating the picture are deposition and later movement of salt and other evaporites and occasional volcanic intrusions. In almost all Arctic areas, the configuration and movements of the basement are basic to an understanding of structural developments. Hence, considerable attention must be devoted to Proterozoic structural movements as well as to later ones.

Generally, Proterozoic-Caledonian structures may show a south-north alignment. The Boothia Arch may be a good example of this. Some of the Proterozoic tectonic belts may have been rejuvenated during the Caledonian disturbance. It is probable that north-south trending structures on Cornwallis Island have such an origin. Two directions of folding are observed on Cornwallis—the northern direction is found in structures of Caledonian time; the east-west trending structures date to Hercynian time.

Proterozoic events. The old mobile belt was an ancient geosynclinal zone extending from Ellesmere Land through northern Greenland and Spitsbergen to Scandinavia. This zone separated the Arctic Mass from the Canadian-Greenland Shield. It may have extended into northern Alaska and the Rocky Mountains during the early Proterozoic.

Most of the Canadian Arctic islands territory has a sedimentary cover deposited on a very complicated crystalline basement. Mobile belts involving pre-Cambrian basement rocks controlled development of the many basins.

On northern Greenland and Ellesmere Land there was a Proterozoic geosyncline, a continuation of the Scandinavian geosyncline which also traversed Spitsbergen. This geosyncline was separated westward into two branches. The approximate apex is the Hazen Lake area of Ellesmere Land. The northern branch continued into northern Alaska; the southern branch may have died out southwestward. During Proterozoic times heavy deposition of marine dolomites and limestones topped by evaporites occurred in a basin west of the Boothia Uplift and east of a Proterozoic arch in the northwestern part of Victoria Island. Despite the an-

cient age of these sediments, they are evidently not metamorphosed.

The north-south trending eastern Greenland mobile belt began to develop during the Proterozoic and became relatively stable after Caledonian time.

Caledonian structures. The northern Greenland-Ellesmere Land geosyncline continued its development in Caledonian time, stabilizing thereafter. In northern Greenland and northeast Ellesmere Land a premountain trough began its formation in Cambrian times on the southern side of the mobile belt. This trough extends nearly 500 miles from the Bache Peninsula on the east coast of Ellesmere Land to northeast Greenland.

Deposition continued during the lower Paleozoic in the old western Franklin Proterozoic depression on Victoria Island, though over a somewhat diminished area. A new depression developed during Caledonian time on the Canadian Shield on the northwestern part of Baffin Land, Somerset Island and on the eastern side of the Boothia Peninsula. A thick series of Ordovician (including evaporites) and Silurian was deposited on the western side of this depression.

The plunging southern branch of the Ellesmere Land mobile belt was covered by a thick Ordovician-Silurian section. Although part of these sediments was taken up and metamorphosed in the rejuvenated mobile belt during the Caledonian orogeny, the southern portion is not deformed. The southern area could have very good oil reservoir rocks which were gently warped into broad open folds.

In lower Paleozoic times an elongate basinal area or chain of depressions developed in southeastern Ellesmere Land, Cornwallis, Bathurst and Melville Islands. A thick Ordovician-Silurian series is present and a thick Devonian section was also deposited.

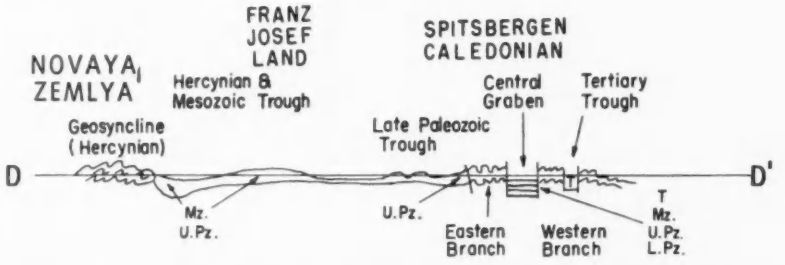


FIGURE 4—Cross-section D-D′ shows relationship between Spitsbergen, Franz Josef Land and Novaya Zemlya. The Spitsbergen Archipelago has a Tertiary trough to the south and a Tertiary-Mesozoic-Paleozoic central graben between two branches of Caledonian mobile belts. The central graben contains sediments of Tertiary Cretaceous, Jurassic and Triassic ages, Permo-Carboniferous evaporites and oil-prospective carbonates, and basal sandstones aggregating about 13,000 feet of thickness. Franz Josef Land has about 5,000 feet of Mesozoic and upper Paleozoic section. Oil may be found there. On Novaya Zemlya Carboniferous and Devonian carbonates, though heavily impregnated with asphaltite, are also highly metamorphosed.

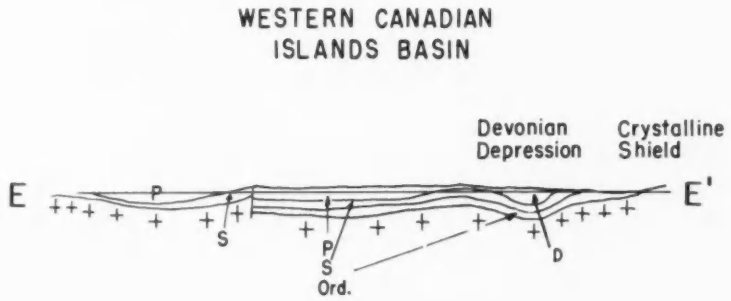


FIGURE 5—Cross-section E-E′ shows generalized structure from the northwestern trough in Prince Patrick and Melville Islands on the west across the northern extension of the Boothia Arch to the crystallines of eastern Devon Island on the east. Permian-Silurian section on the west gives way to Permian-Silurian-Ordovician section eastward. East of the Boothia Arch extension, there is about 4,500 feet of Devonian above the older Paleozoics.

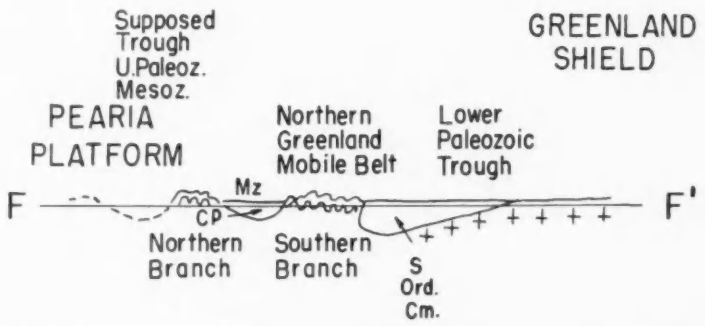


FIGURE 6—Cross-section F-F′ shows the intensely disturbed series of mobile belts in the far north between the Pearia Platform on the Arctic Ocean continental shelf and the Greenland Shield. In the lower Mesozoic—upper Paleozoic trough of Ellesmere Land about 7,000 feet of sediments are found, including bituminous shales in the Triassic, and Permian reefs. South of the northern Greenland mobile belt, a section of lower Carboniferous beds occurs, largely composed of carbonates.

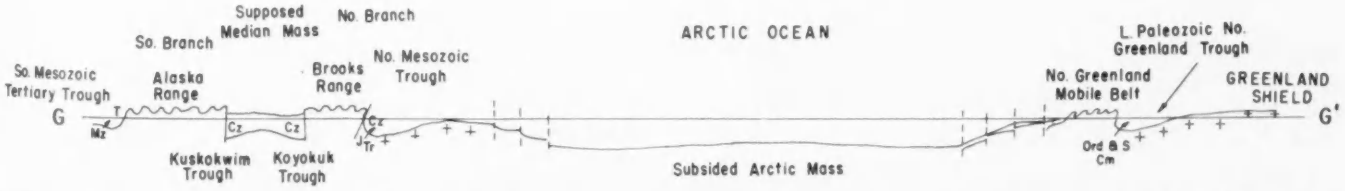


FIGURE 7—Cross-section G-G′ shows the relationship between mobile belts in Alaska, the Arctic Ocean, and northern Greenland. Oil production has been established in Alaska in the southern Mesozoic trough and the northern (Artic slope) Mesozoic trough, and exploration is proceeding in west-central Alaska and in extreme eastern Sibera opposite Alaska.

This chain of Paleozoic depressions is now a zone of central uplift. Behavior of the old crystalline basement had a strong influence on this uplift and also on development of lower Paleozoic structures.

Hercynian structure. Active development of Canadian Arctic Islands structure continued in Hercynian time, when premountain troughs were formed in front of both branches of the Ellesmere Land Caledonian mobile belt. They may actually be two separate Hercynian troughs, one on the northeastern side of Ellesmere Land, the other in Peary Land. The trough of the northern branch of the Ellesmere Land mobile belt was filled with unaltered Carboniferous sediments. Some reefs may have been formed. This premountain trough is connected with the rim of the Arctic Mass.

The Hercynian trough on the western side of the southern branch of the Caledonian mobile belt in Ellesmere Land was filled with Permo-Carboniferous beds, including some reefs.

A very important depression, with some features of a deep trough formed in Hercynian time in the Queen Elizabeth Islands area. This depression is on the median mass between the two branches of the northern Greenland-Ellesmere Land mobile belt. This depression is limited in the north by the Hazen Lake vicinity of Ellesmere Land and on the south by the central uplift of Melville, Bathurst and Cornwallis islands. On the northwest the depression covers the buried northern branch of the Ellesmere Land mobile belt and comes close to the rim of the Arctic Mass.

A very thick series of upper Paleozoic sediments was deposited in this depression. Its axis is toward the western side and parallels the buried northern branch Proterozoic mobile belt. Along this axis the crystalline basement subsided very sharply, either forming a graben or graben system or a very steep flexure. There is no evident metamorphism.

Diapirs were formed by evaporites along the axial zone. The eastern flank of the depression is the slope of the median mass rising to the east. Still farther eastward, there is another deep premountain trough which contains reefs.

Mesozoic-Tertiary structure. The Queen Elizabeth Hercynian depression continued development during Mesozoic and Tertiary times. About 40,000 feet of Mesozoic sediments were deposited as a deep trough or system of deep grabens developed further. On the southwest, this depression merges with the premountain trough of western Canada.

The eastern Franklin Caledonian depression may have developed some grabens in Cretaceous time in conjunction with Cretaceous grabens in Baffin Land. Cretaceous deposits similar to those of Disko Island in western Greenland may have been laid down in these grabens.

The old Caledonian mountains were uplifted in Laramie and Tertiary times.

Resulting structural trends. From the foregoing, the complex structural history and nature of the Canadian Arctic Islands can be appreciated.

In the Elizabeth Islands Hercynian trough there are two structural axes. The northeast trend is clearly shown by the line of diapirs along the axis of the depression. The second direction is more northerly, ranging to northwestward, owing to Cenozoic rejuvenations of both branches of the old mobile belt.

This platform-type deep trough is similar to the Viluyi depression on the Siberian platform where large reserves of oil and gas have been found in salt structures. Whether the diapirs in the Queen Elizabeth Islands are similar to those in the Richardson Mountains in the Northwest Territories is not clear. The age of the salt may not be the same. The Richardson Mountains salt could be Cambrian—in the Canadian Islands, the salt is Carboniferous or Permian.

Intrusive igneous rocks are found in many places in the Canadian Islands, usually as dikes, often in sills. On Bathurst Island there are dikes and small bodies of olivine basalt associated with faults which are younger than Hercynian folding. Farther north in the Queen Elizabeth Islands there are many igneous dikes, particularly in the eastern part. In some areas, such intrusions may preclude the existence of oil and gas fields. In other areas, they may have formed favorable structural traps for them. Precise geophysical work, including ground magnetic surveys, should accompany geological surveys of structures in such areas.

This relatively young vulcanism shows that basic magma has penetrated thick sedimentary overburden, not only along the old mobile belts, but in median-mass areas also. This is further evidence of the likelihood of shifting of structure with depth and the need for detailed evaluation of surface structures through use of geophysical methods.

About the Author

Dr. Leonid Smirnow is a consulting geologist and petroleum engineer, currently active in evaluation of Alaskan oil prospects. He was born and educated in Russia and first worked at the Petroleum Geological Research Institute of the Soviet Union. In 1932, Smirnow became head departmental geologist of the Urals and Emba section of the Institute. From 1933 to 1940, he was chief geologist of a petroleum expedition in the Siberian Arctic. In 1941, he became professor of the Institute of Mines in Leningrad. His work, specialized in the relation of oil formations to evaporites in depositional basins, led to oil discoveries in the Ural trough and in the Russian Arctic. In 1949, he began work in the United States as a consultant to Standard Oil Co. (N. J.) and Standard-Vacuum Oil Co. In recent years Smirnow has been a consultant to Holly Corp. in New York City, where he now lives. Smirnow wrote a four-article series, "Oil in Russia," the first part of which appeared in the October 1951 issue of WORLD OIL. He is a member of AAPG and of The Society of Petroleum Engineers of AIME.

BIBLIOGRAPHY

Brechtel, F. C. and Gould, D. B., "Arctic Islands allow fast photogeologic evaluation," WORLD OIL 150, No. 8, 103-108 (1960).

Fortier, Y. O., McNair, A. H., and Thorsteinsson, R., "Geology and Petroleum Possibilities in Canadian Arctic Islands," The American Association of Petroleum Geologists *Bulletin* 38, No. 10, 2075-2109 (1954).

Pratt, W. E., "Petroleum in the Polar Areas," World Geography of Petroleum, Princeton University Press, pp. 308-318, American Geographical Society Special Publication No. 31 (1950).

Pratt, W. E., "Petroleum on Continental Shelves," A A P G *Bulletin* 31, No. 4, 657-672 (1947).

Pratt, W. E., "Oil Fields in the Arctic," *Harper's*, January, 1944.

Smirnow, Leonid, "Oil-bearing basins of the Eastern edge of the Russian Platform," Habitat of Oil, pp. 1176- , The American Association of Petroleum Geologists, Tulsa, (1958).

Flowing well logs can save you money

Savings include decreased rig time, reduced production and exploitation costs. Early application may increase secondary recovery

By H. L. Bryant, Engineer
Creole Petroleum Corp., Tulsa

FLOWING WELL logging operations are used to solve production problems and to evaluate production conditions which exist in dynamic form. Substantial savings in rig time, reduction of production and exploitation expenses, and increased recoveries are some of the benefits already realized from flowing well logs. Early application of flowing well logging operations for evaluation purposes can lead to more efficient well production and increased secondary recovery.

To carry out successful logging operations in a flowing well, the following are prerequisite conditions:

1. Tubing must be unobstructed
2. Logging tool must have a diameter small enough to pass through the tubing
3. Well must be entered under pressure without disturbing production or injection.

The first two conditions need no special mention. A lubricator and a section of tubing can be attached to the wellhead to satisfy condition number 3. If the logging tool has insufficient weight, additional weight can be added in the form of sinker bars. Cable sizes of 3/16 inch and 5/16 inch permit logging operations over a wide range of presure conditions.

In well workover work, flowing neutron and flowing fluid density logs can be used to locate gas and water entry. Well evaluation work—evaluation of stimulation treatments, secondary recovery projects, etc. may call for a borehole flow profiling technique.

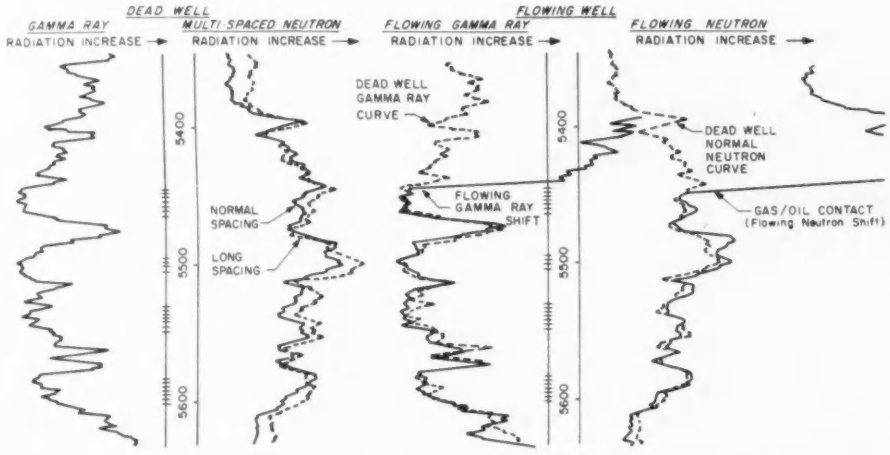


FIGURE 1—Here is a field example of a successful flowing neutron log. Note the obvious gas-oil contact. Multi-spaced log at left does not indicate contact.

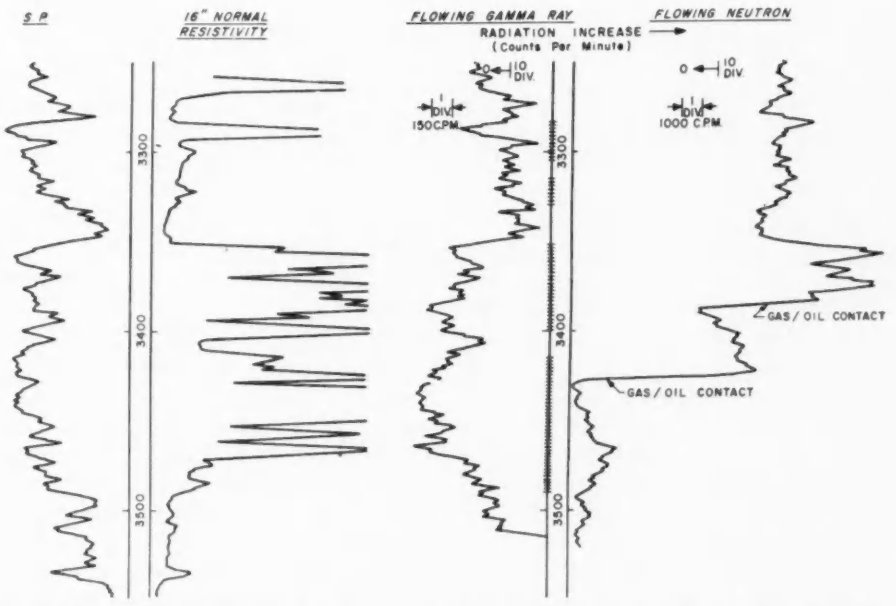


FIGURE 2—This flowing neutron log indicates two gas-oil contacts. Where multiple contacts are present, a static log taken with the well dead is desirable.

Flowing neutron logs. Before a petroleum reservoir is depleted, individual well production may suffer from encroaching water, an expanding gas cap, or possibly both. Gas and gas/oil contacts have been successfully located by temperature, neutron, multi-spaced neutron and flowing neutron logs.

The flowing neutron logging tech-

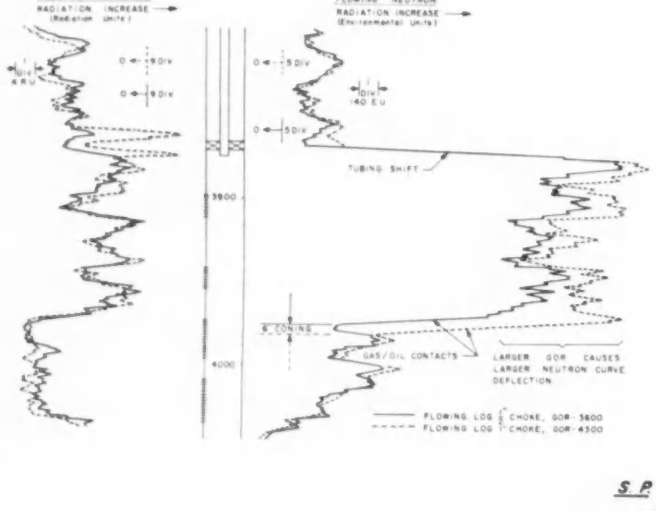
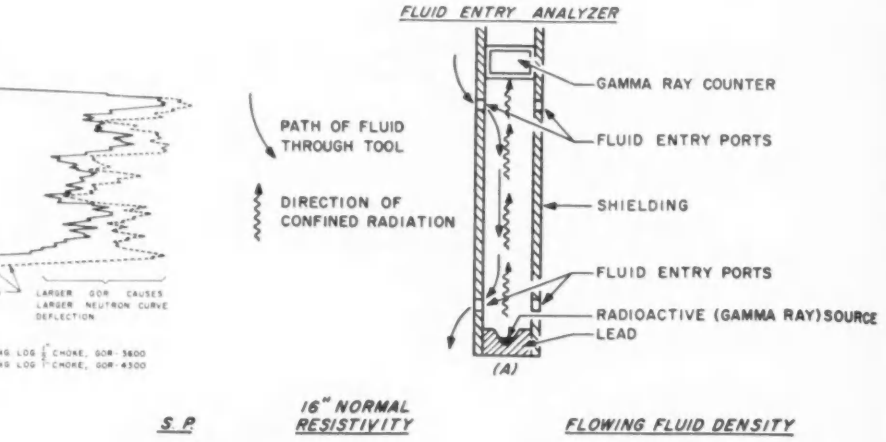


FIGURE 3—Gas coning in thick sands produced at high flow rates can be detected by the flowing neutron log. By changing chokes, the coning is apparent. Note that a higher COR results in a higher neutron curve response.



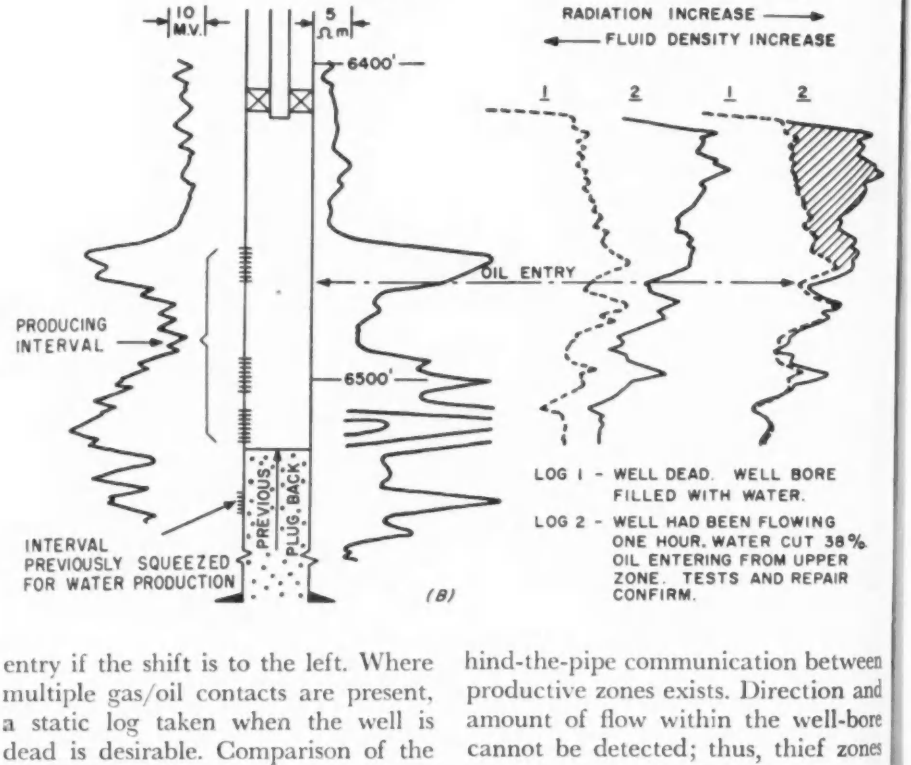


FIGURE 4—The flowing fluid density log is obtained by use of the tool shown in Figure 4A. Figure 4B shows how water entry may be detected with this technique.

nique capitalizes on the effects of borehole fluid on the neutron curve. The sharp increase in radiation intensity above a static liquid level is a result of the greatly decreased amount of neutron-absorbing hydrogen present in the air filled part of the well bore. A similar condition exists in a flowing well at points of gas entry. Figure 1 is a field example of a successful flowing neutron log obtained after the conventional neutron log and the multi-spaced neutron log failed to locate the gas.

Gas production from more than one of several intervals open to production can present difficult log interpretation problems. Flowing neutron logs have been used to detect oil entry above a gas/oil contact and also multiple gas/oil contacts. Figure 2 illustrates location of two gas/oil contacts. Shifts of the flowing neutron log due to borehole fluid indicate gas entry if the shift is to the right, or oil entry if the shift is to the left. Where multiple gas/oil contacts are present, a static log taken when the well is dead is desirable. Comparison of the static and flowing logs will permit more positive interpretation of formation effects.

Gas coning in thick sands producing at high flow rates can be detected with the flowing neutron log. Information of this nature is of particular interest to the reservoir engineer. Figure 3 demonstrates how a repeat run after a choke change can show gas coning. This figure also shows how a higher gas/oil ratio (dotted curve) results in a higher neutron curve response.

Flowing neutron logs have been used with good results in Venezuela, Canada, Arabia and the United States. The greatest limitation of the flowing neutron technique is that it is applicable only to flowing wells. Interpretation will be doubtful if behind-the-pipe communication between productive zones exists. Direction and amount of flow within the well-bore cannot be detected; thus, thief zones may also go undetected.

Flowing fluid density logs. Different gamma ray absorptivities in different density fluids provide the basis for the flowing fluid density logging tool (Figure 4A). The tool is constructed to divert well bore fluid between a gamma ray source and a detector. The radiation remaining after passage through the fluid can be related to the gamma ray source intensity by Lambert's Law, $I = I_o e^{-\mu t}$, where:

I = recorded gamma ray intensity
I_o = source intensity
e = base of natural logarithm
t = distance, source to detector
μ = linear absorption coefficient

For low energy gamma radiation the linear absorption coefficient di-

vided by the density of the absorber is almost constant. Thus with a known source to detector spacing the radiation recorded will be a measure of the fluid density passing through the tool.

In practice, interpretation of the fluid density log consists of comparing a static log with a flowing log or logs. If, for example, the well produces with an appreciable water cut, the static log will be obtained with the borehole water filled. When the flowing log or logs are obtained the borehole will be water filled up to the first point of oil entry. At that point the gamma radiation intensity will increase, indicating a less dense borehole fluid mixture.

Figure 4B is a successful field example locating water entry. This technique also has been used to locate gas entry.

Borehole flow profiling. The popularity of secondary recovery projects has brought renewed interest to subsurface borehole flow profiling. However, application of borehole flow profiling need not be restricted to secondary recovery projects or reservoir engineering studies. Flow profiles can be used to evaluate hydraulic fracturing techniques and other completion methods. Well workovers can be facilitated by using flow profiles in combination with other flowing log techniques to locate water and gas entry, tubing and casing leaks, and thief zones.

Many instruments and techniques have been developed by oil companies and service companies to obtain flow profiles. In the ultimately desired form, flow profiles should indicate the amount, direction, location and type of fluid flowing into or from a well bore. Flow profiles have been obtained by (1) static interface methods, (2) dynamic interface methods, (3) temperature surveys, (4) radioactive methods, (5) electrical methods, and (6) metering devices. No single instrument or technique has been completely satisfactory for all profiling operations.

The inflatable packer flowmeter (see World Oil, Feb. 15, 1960, Page 149) developed by Humble Oil & Refining Company has been used successfully to profile injection and producing wells (Figure 5A). Profiling operations consist of inflating the packer at a number of points through the production or injection interval and recording the spinner velocity. By plotting the packer setting depths versus spinner rpm a flow rate log can be constructed (Figure 5B). The injectivity or productivity profile then is calculated from the flow log as shown in Figure 5C.

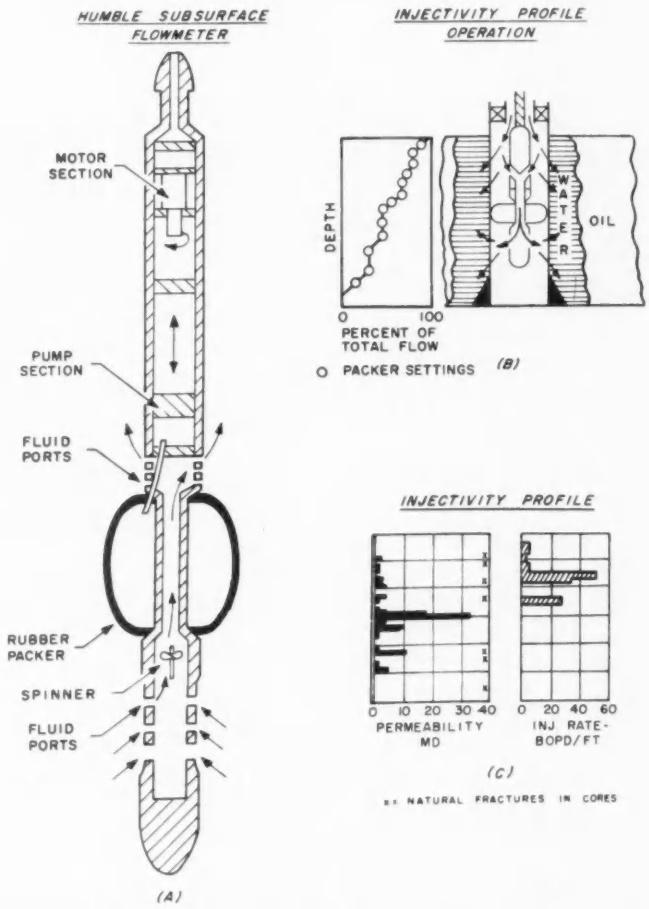


FIGURE 5—The Humble subsurface flowmeter (Figure A) can be used to profile injection and producing wells. Figure B shows how a flow rate log can be constructed by plotting tool setting depth versus spinner rpm. Figure C shows the injectivity (or productivity) profile calculated from the flow log.

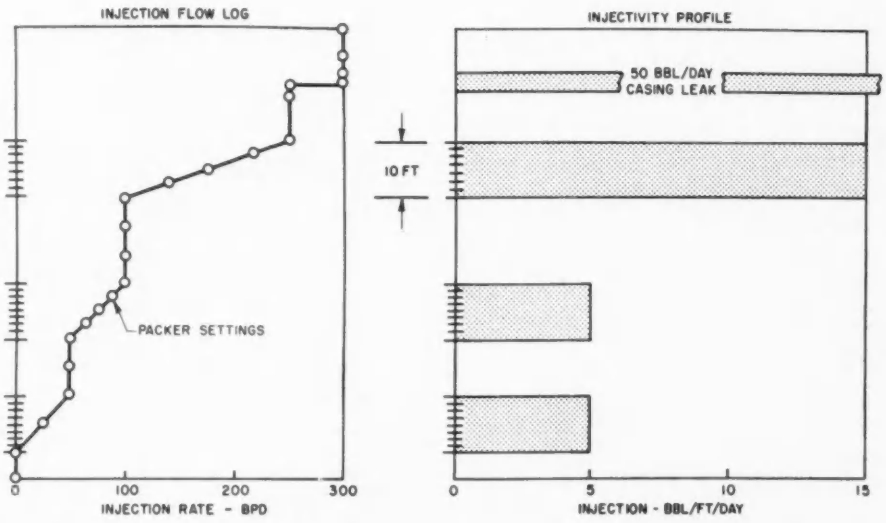


FIGURE 6—The flowmeter can be used to detect casing leaks or other fluid losses. This injectivity profile clearly indicates the leak.

Field tests indicate the inflatable packer flowmeter may be used for continuous flow profiling. The technique consists of partially inflating the packer at the bottom of the well and then dragging it up the wellbore, si-

About the Author

Harvey L. Bryant received a BS degree in geological engineering from the University of Oklahoma in 1951. In 1955 he returned to the University of Oklahoma for advanced work in Geophysics. In the same year, he joined Creole Petroleum Corporation of Venezuela where he worked as special studies geologist and engineer in fields of geophysics and well logging, and as operations geologist for 1958-1959 Barinas Basin exploration. He is currently on a one-year assignment with Jersey Production Research of Tulsa, in the well logging research section.

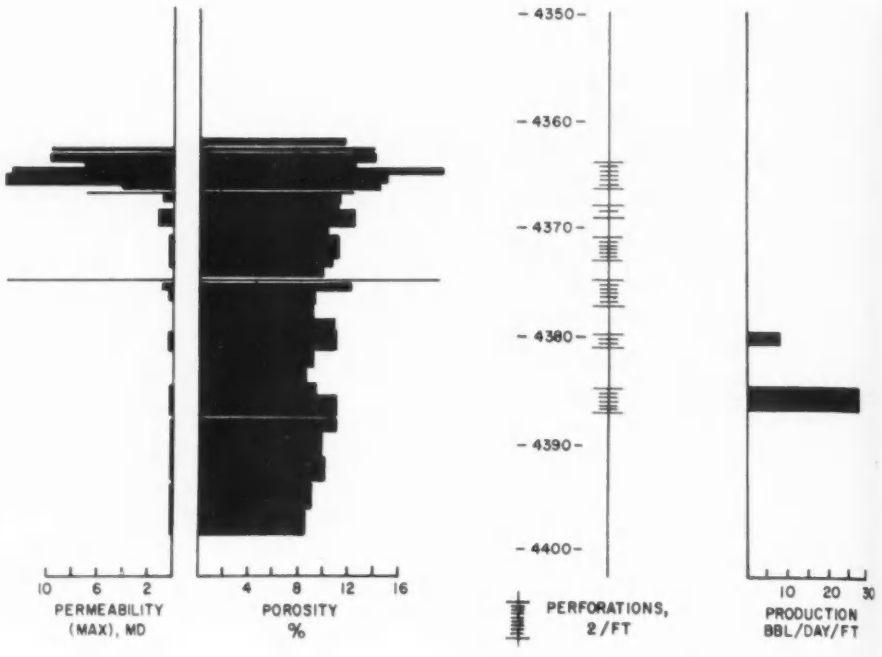


FIGURE 7—Here is a production profile obtained with the subsurface flowmeter. Note that produced fluid is coming from only two of six perforated intervals.

multaneously recording depth and flow rate. Where a conventional profile may take 6 to 8 hours, the "drag-bag" profile is obtained in a few minutes.

The injectivity profile shown in Figure 5C has been typical of the many injection wells logged. The profile shows the injection water to be entering a low permeability section. This lack of correlation between the permeability from cores and the flow profile was attributed to extensive natural fractures in the upper injection interval. Plugged perforations and formation damage can cause comparable flow profiles. Figure 6 demonstrates how casing leaks and other fluid losses can be pinpointed by borehole profiles.

Figure 7 shows well production coming from only two of six perforated intervals. This production is coming from a section of the formation known to have low permeability but with a few limited natural fractures. Figure 8 shows the production profile of an offset well where, as a result of the previous profile information, improved perforating, fracturing and completion techniques were used in completing the well.

Many production profiles have shown all production to come from one foot of the total perforated interval. Where several production zones are open together, thief zones have been located. Early utilization of flow profiles to locate these problems can be profitable in the orderly development and exploitation of most oil fields.

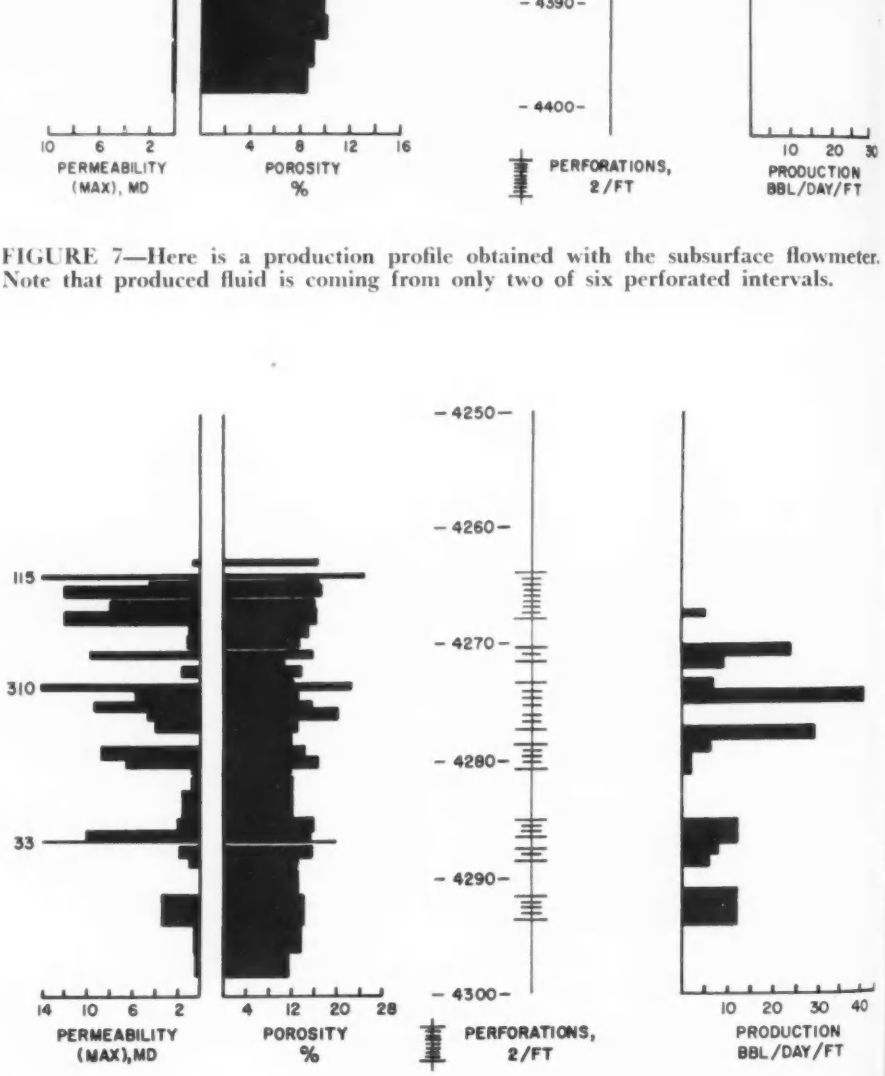


FIGURE 8—This offset to the well profiled in Figure 7 was completed on the basis of the previous survey. Improved completion techniques resulted in all zones producing properly.

This article is based on a paper presented to the First Annual Meeting of the Society of Professional Well Log Analysts, Tulsa, 1960.—**The End**

FIGURE 1—Unconsolidated Miocene sand recovered in a rubber sleeve core barrel. (A) Folded back portion of rubber sleeve that was slit open; (B) Portion of core still encased in rubber sleeve; (C) Core just removed from rubber sleeve showing unconsolidated nature; (D) Partially open rubber sleeve.

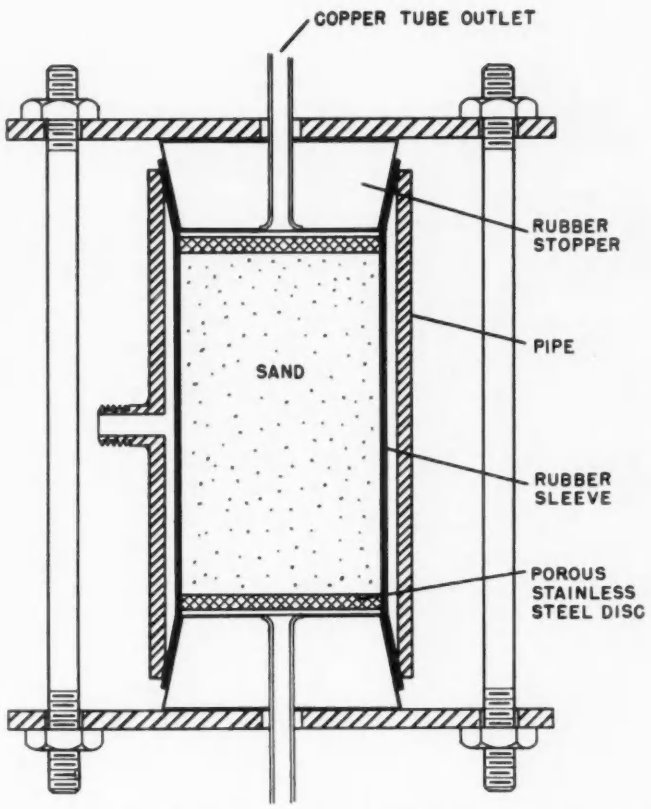


FIGURE 2—The Hassler holder is used for running relative permeabilities.

New technique increases core recovery

Continental reports that rubber sleeve core barrel is recovering 90 percent or better of cored intervals in unconsolidated sands

By C. F. Knutson
E. W. Sutton and
R. J. Cavanaugh, Continental Oil Co., Ponca City, Okla.

THE NEWLY DEVELOPED rubber sleeve core barrel is consistently recovering 90 percent or better of the cored intervals in the unconsolidated Gulf Coast Miocene and Oklahoma basal McLish formations. Recovery of conventional cores heretofore in these zones have ranged from zero to 20 percent, and most of this was from the shalier or siltier portions of the formations.

This new technique was used in an attempt to recover uncontaminated samples and fractured reservoir material. Fifteen to 20-foot cores were taken through these unconsolidated sands and detailed studies were made of the respective intervals.

Based upon Continental Oil Company's experience gained in the above areas of operations, the rubber sleeve core barrels offer the following:

- An excellent means for coring unconsolidated sands.
- Little, if any, advantage over conventional core in obtaining uncontaminated samples.
- Method for studying highly fractured formations.
- Shipping and laboratory study of these cores are facilitated by their being enclosed in the rubber sleeve.

The rubber sleeve core may be

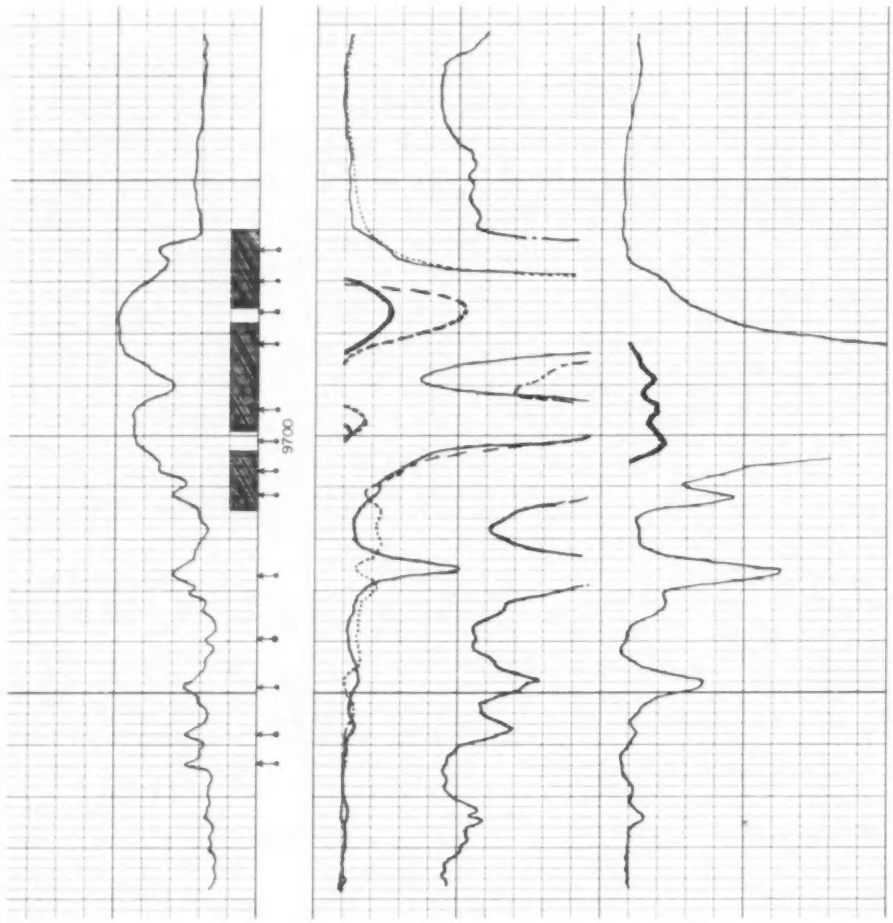


FIGURE 3—An electrical survey illustrating the same zone that was cored by conventional sidewall methods.

shipped without removing from the (rubber sleeve) container. The entire core is cut into 3-foot sections with a hack saw, the ends are encased in plastic bags sealed with rubber bands, and then are shipped in conventional 3-foot x 4-inch x 4 inch core boxes (Figure 1).

Lab evaluation. The core is handled in the laboratory using two different techniques. If plug analyses are to be performed, the 3-foot sections of core are examined and sampled after the sleeves have been slit longitudinally. Plugs approximately ⅞ of an inch square are hand carved or dry cut on a diamond saw. They are then oven dried or retorted to drive off the hydrocarbon and water. The clay content and/or hydrocarbon residue is sufficient to maintain competency during careful porosity determinations. The porosities must be corrected for residual hydrocarbon content. The plugs are then wax or plastic mounted for permeability measurements.

Large core analyses are also possible, if the rock properties are sufficiently isotropic. The core still encased in the rubber sleeve is fitted into a Hassler type holder (Figure 2).

The holder is formed by (1) carefully removing approximately one inch of sand from each end of the core; (2) smoothing the end of the core and making it a plane which is perpendicular to the axis of the section; (3) placing a porous stainless steel disc against each end of the core in its rubber sleeve core; (4) placing the section of core in its rubber sleeve inside a steel pipe with I.D. slightly larger than the sleeve; (5) placing rubber stoppers (fitted with ¼-inch copper tubing) into each end of sleeve; (6) placing end plates over stoppers; and finally (7) supplying (through a suitable fitting in the side of the pipe) 125 psi air pressure and then tightening down the outside end plates until the stoppers seal off the air escaping from the ends of the pipe.

The core (usually 6 to 12 inches long) has enough volume so that initial water, oil, and gas saturations can be determined by a material balance, restored state, and final saturation method. In addition k_g/k_o and k_w/k_o curves may be obtained.

Validity of the assumption of the approximate isotropic formation characteristics was partially checked in that the k_g/k_o and k_w/k_o curves were essentially the same as the unconsolidated sand curves of equivalent permeability reported in the literature—run by Botset, and Leverett & Lewis and reported in all the standard reservoir engineering texts.

The laboratory operation for performing the previously mentioned tests is:

- Bring the mounted core up to 100 percent liquid saturation with a heavy oil, and then measure the water produced, original gas volume, and oil permeability.
- Run Welge type relative permeabilities (k_g/k_o).
- Run brine and fresh water permeabilities and determine bulk volume, grain volume, and liquid saturation using the solvent extraction method.

Porosity and liquid saturations obtained with this technique agree with the values calculated from electric logs for these intervals.

Comparison of data. In certain areas, it is common practice to sample potential oil or gas bearing horizons using sidewall coring techniques. This practice is quite prevalent in the Louisiana and Texas Gulf Coast region where the Miocene sands are the principal producing objectives. The procedure generally is to run the electrical logs and then to sample intervals which the logs indicate as being possibly hydrocarbon bearing. The recovered sidewall samples are then examined for fluorescence and cut to determine the presence of oil or gas. If the cores recovered are large enough, porosity and permeability measurements are made.

Sidewall coring has become popular in the Gulf Coast area for several reasons.

- The nature of the bit cuttings in this area makes it practically impossible to evaluate the sands by examination of the cuttings.
- Electric logs are sometimes affected by the extreme shaliness of the

sands, and it becomes very difficult to recognize hydrocarbon bearing zones.

The sidewall core, although a very helpful aid in many cases, presents several drawbacks. These are:

- Recovered core is not of sufficient size to permit proper analysis.
- Core sample is so greatly contaminated with drilling mud that it is not representative of the reservoir.
- Mechanics of obtaining the sidewall core probably altered the sand grain arrangement so as to make even porosity and permeability questionable.

Development of the rubber sleeve core barrel has made it possible to evaluate these unconsolidated Miocene sands using full diameter core techniques. With full diameter core data available, which should be more representative of the actual reservoir, data obtained from sidewall cores can be compared and evaluated.

Such a comparison was made for a Miocene sand in the Gulf Coast area. This interval was first cored using the rubber sleeve core barrel (Figure 3 is an electrical log of the interval). Excellent recoveries were obtained. After coring and logging, sidewall cores were taken at depths selected from the electric log. Porosity and permeability measurements were made on both the sidewall cores and the rubber sleeve core. Some of the rubber sleeve core measurements were full diameter analyses made with the core still encased in the sleeve; others were plug analyses. Comparison of the porosity and permeability data are shown in Figures 4 and 5.

Figure 4 shows a comparison of the porosity values. Although in most cases there is not too great a difference in the actual porosity values, this comparison seems to indicate that the sidewall core porosities are generally higher than the full diameter core porosities. Figure 5 shows the comparison of the permeability values. This comparison shows that a wide variance may exist between sidewall core permeabilities and conventional size core permeabilities. The results indicate that the sidewall core permeabilities are generally lower than the full diameter core permeabilities.

The comparisons as shown in Figures 4 and 5 are in agreement with the investigations of Webster and Dawsongrove.[1] These studies showed that sidewall core porosities in high porosity sandstones were generally slightly higher than full diameter core porosities. They also found that in highly permeable sands full diameter core permeabilities were much higher than sidewall core permeabilities. Webster and Dawsongrove explained that the lack of comparison between the porosity and permeability values is due to the alteration of the sand grains and sand grain arrangement as the sidewall core is taken.

Uncontaminated core. It seems logical that the rubber sleeve core barrel should be more effective in obtaining an uncontaminated core than a conventional core barrel. Several evaluations of its applications in recovering uncontaminated core have been made.

One situation in which the rubber sleeve core barrel was used was in the coring of the Booch sand in Seminole County, Oklahoma. It was particularly important in this case that accu-

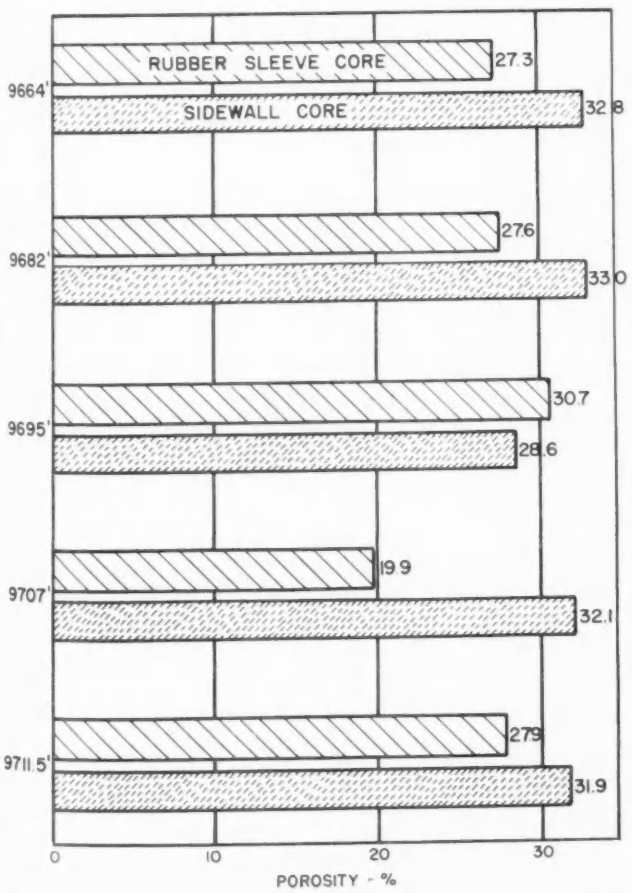


FIGURE 4—A comparison of the porosity while using the sidewall and rubber sleeve recovery methods.

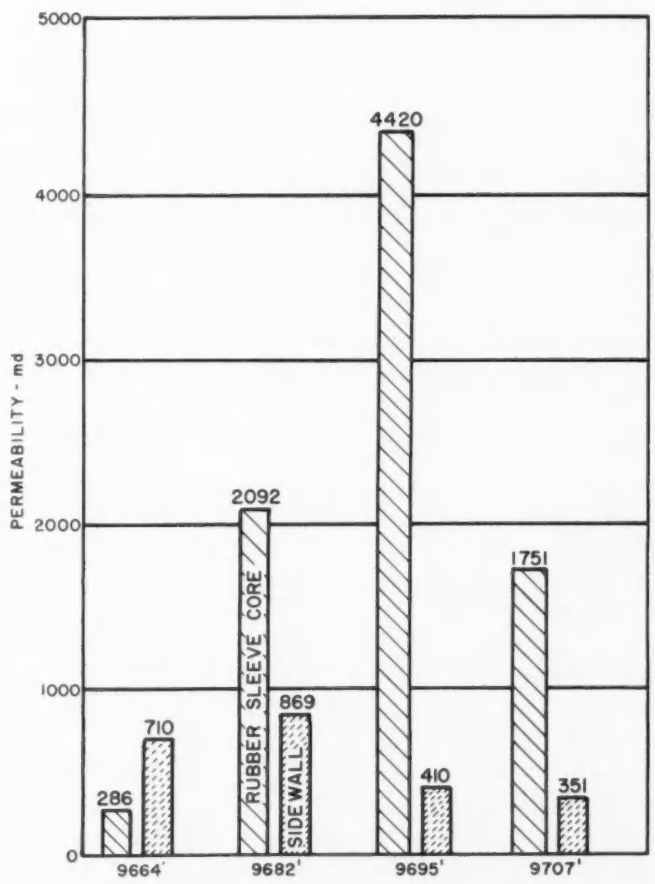


FIGURE 5—The permeability of the formation varies considerably with the type of coring method.

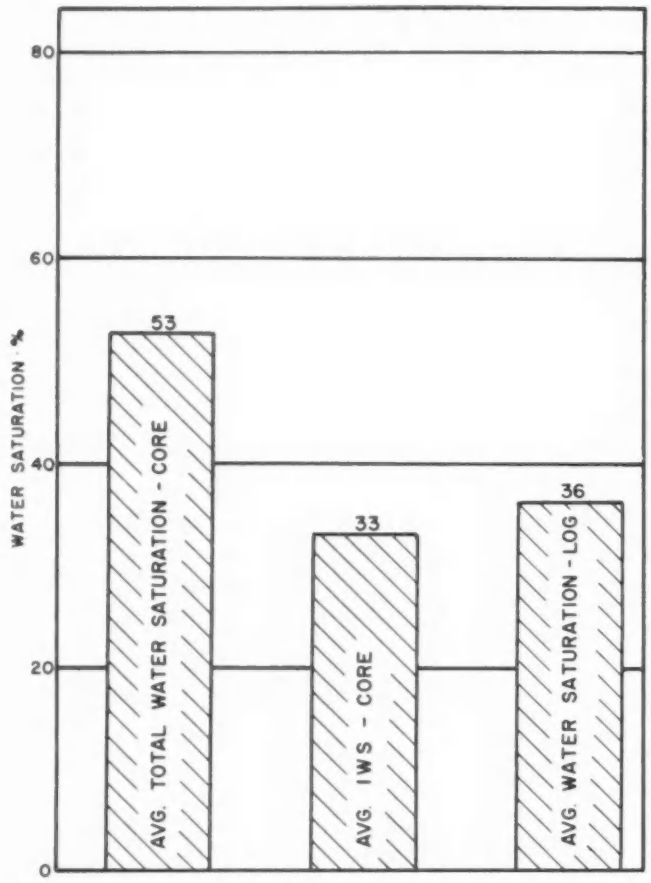


FIGURE 6—A comparison of the water saturation obtained from the core analysis of a specific interval versus that of an induction-electrical log of the same interval.

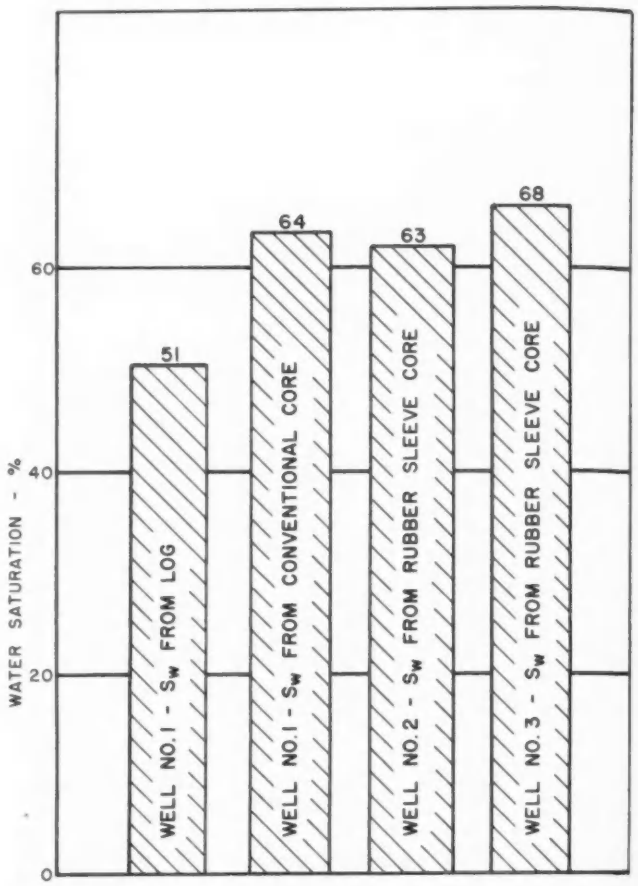


FIGURE 7—The water saturation is approximately the same regardless of the type of coring method used. These results were obtained from the shallow Cretaceous sand of South Texas.

rate values of water saturations be obtained. For these purposes, steps were taken so that a minimum of core contamination would exist. It was decided to core the sand with the rubber sleeve core barrel using a low fluid loss mud. After coring, an induction-electric log and microlog were run. Figure 6 shows a comparison of the core and log water saturations.

It can be seen that the total water saturation as determined from the core is considerably higher than the water saturation as calculated from the log. The irreducible water saturation and the log compare rather closely. It is felt that the log water saturation is reliable, since the formation factors were obtained from the core and a sample of the formation water was available. The true formation resistivity was derived from the induction log and should be reliable since, in this case, the invasion probably was slight. In this particular case, then, it seems that the rubber sleeve core barrel was unable to prevent contamination.

An unusual opportunity to evaluate the rubber sleeve core barrel was offered during the drilling of several wells in South Texas. The objective horizon in these wells was a shallow Cretaceous sand. Three wells were drilled during this program Well 1, Well 2, which was 150 feet from Well 1, and Well 3, 50 feet from Well 1. Well 1 was cored with a conventional core barrel, while Wells 2 and 3 were cored with the rubber sleeve core barrel.

A comparison of the core water saturations for the three wells is shown in Figure 7. The water saturation as calculated from the induction log for Well 1 also is shown. Since these wells are close to each other, it is reasonable to assume that the water saturations should be fairly uniform. Figure 7 shows that the core saturations are practically equal, no matter what coring technique was used. The log saturation, which should be reasonably accurate, is significantly lower than the core saturations. This series of tests indicates that the rubber sleeve core barrel was unable to prevent contamination.

Facilitates fracture studies. The rubber sleeve core barrel also has been used to recover and facilitate processing of fractured carbonate reservoir rock. The 90 percent rubber sleeve core recoveries were higher than prior conventional core recoveries in the same zone.

The fractured core still encased in the rubber sleeve was cut into 3-foot sections and alternate 3-foot sections were encased in plastic briquettes at the rig site. Details of technique used are found in the literature.[2]

When the rubber sleeve was removed from the plastic encased cores in the laboratory, it was found that the cores were encased and the open fractures were filled with plastic. The plastic had not penetrated into the core or small fractures. Thus these sections of core were available for studies of matrix and fracture permeability.

LITERATURE CITED

[1] Webster and Dawsongrove, "The Alteration of Rock Properties by Percussion Sidewall Coring," *Journal of Petroleum Technology*, Vol. XI, No. 4 (April, 1959) pp. 59.
[2] Conley, Glover, Knutson, "Field Consolidation of Fractured Core," *Journal of Petroleum Technology*, Vol. XI, No. 12 (1959) pp. 35.

Radioactive gas tracer survey aids waterflood planning

Technique used to confirm directional trend of main Spraberry fracture system

By **W. D. Howell,** Petroleum Engineer
F. E. Armstrong, Project Leader
J. Wade Watkins, Project Coordinator
U.S. Bureau of Mines, Bartlesville

A RADIOACTIVE GAS TRACER SURVEY has been used to correlate the directional trend in fractures and has aided in planning a water-injection system in the Spraberry Trend of West Texas. Tracer gas was detected at two wells slightly off a southwest-northeast diagonal line predicted on the basis of core fracture orientation as being the probable directional trend of the natural sandstone fractures.

The engineering approach devised for the Spraberry reservoir also would be useful in other naturally fractured reservoirs, such as some of the Rocky Mountain sandstone formations, and numerous limestone formations. The techniques developed are applicable to gas-tracer tests, under varied circumstances, in stimulative projects using gas injection, water injection, miscible-phase displacement and combustion to increase production.

The extensive Spraberry Trend is an anomalous sandstone reservoir because permeability is low and oil is displaced primarily from fractures rather than interstitially. The results of experimental water-injection systems have been encouraging,[1] indicating that normally low primary production can be increased by waterflooding, partly through the phenomenon of water imbibition.

Although the Spraberry is a notable example of a fractured-type sandstone reservoir, other sands such as some of the Rocky Mountain formations and numerous limestone reservoirs produce oil principally from fractures, vugs, or fissures, rather than from interstitial pores.

In the Spraberry formation, principal zones of liquid conductivity may be expected to have some directional orientation.[2] Numerous theories have been offered as to the cause of the fracture systems in the Spraberry sandstone. The most accepted theory is that the fractures were caused by shrinkage of the formation at a considerably later date than when the formation was deposited. Vertical shrinkage was compensated for by compaction of the rock and horizontal shrinkage by the fractures in the formation. In cores taken from the Spraberry, fracture frequency has been observed to occur from one inch to every four inches in a general NE-SW direction.

A cross fracture system perpendicular to the main NE-SW system was found in some cores. Fracture occurrence in this system is considerably less than that of the main system. For the Spraberry formation as a whole,

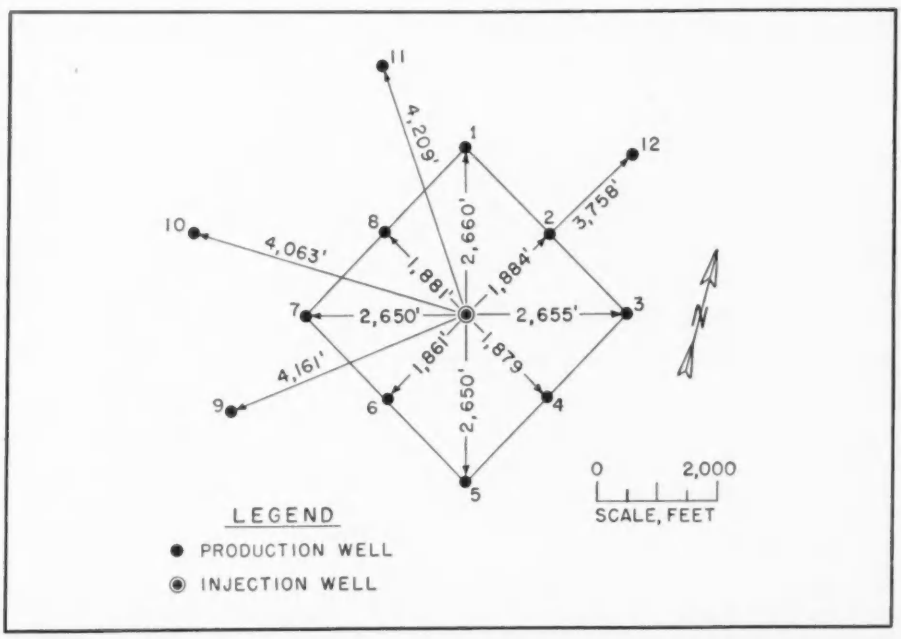


FIGURE 1—Central well of a nine spot group was used for injection. Only wells 2 and 9 detected radioactive gas.

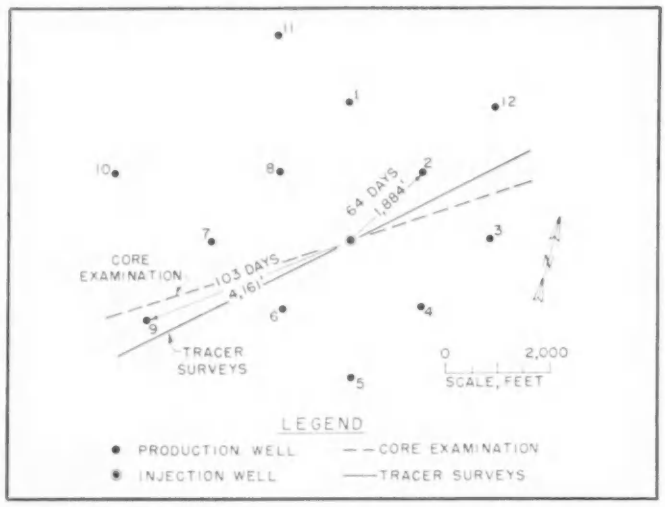


FIGURE 2—Lines show fracture orientation as predicted from core examination and indicated by non-radioactive tracer tests. Radioactive tracer test indicated fracture orientation to be a few degrees off the solid line shown.

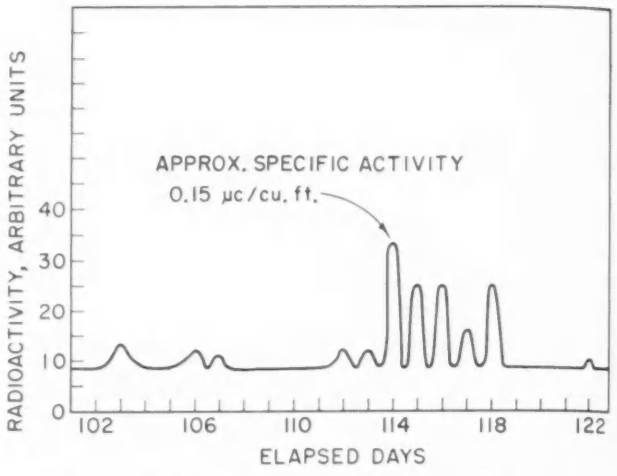


FIGURE 3—Produced gas first indicated radioactivity increase 103 days after injection commenced. Increases were cyclic, and magnitude was greater than at well 2. Peak radioactivity occurred at 114 days and equaled about 0.5 of injection concentration which indicated only slight dilution within the reservoir.

permeability along the main fracture system has been estimated to be 144 times greater than the permeability through the cross fracture system. To take full advantage of the directional fracture system, water-input wells should be drilled on a line parallel to the main fracture system. The cross fractures thereby will be filled with water, pressure in the reservoir will increase and the driving fluid will be forced into and through the rock matrix and through the cross fractures to the principal fracture plane along a broad front. Most of the water that enters the rock matrix will do so through capillarity. Oil will be forced ahead of the water front until it reaches the next axis of fracture passing through a production well, thereby permitting the production of some oil from the rock matrix as well as from the fractures.

The directional orientation of such fracture systems may be determined from examining oriented cores cut from the productive formation. This method is not completely dependable because of the difficulties of exact orientation and because of incomplete core recovery. Where wells have been drilled for primary production, a tracer survey may be made to define the fracture plane more exactly.

Radioactive tracers have been proved to be effective in defining fracture patterns in existing waterfloods.[3] However, the planning of a water-injection system for a fractured reservoir requires prior knowledge of the orientation of fracture systems and the use of a liquid tracer requires at least a pilot water-injection system. Unfortunately, reservoir characteristics and depth of the Spraberry formation are such that even a pilot waterflood must be a comparatively large-scale, lengthy and costly operation.

For these reasons, one group of operators decided to compress and inject radioactive natural gas into a central well to define the fracture pattern of the Spraberry Trend in Reagan County, Texas. The assistance of the Bureau of Mines was solicited in devising and applying the techniques and instruments required to make a radioactive-gas-tracer survey during the experimental gas-injection program.

Productive formation and property. Cumulative production from the Spraberry Trend to December 31, 1959, was 163,280,000 barrels of oil. Average output per well was 19 bopd, and cumulative recovery was approximately six to eight percent of oil in place.

An area of some 305,000 acres in West Texas has been developed in the Spraberry Trend, with 2,169 wells completed in the two principal productive zones. In the immediate area of the tracer survey, the upper zone (average subsurface depth 6,400-6,600 feet) has an average of 30 feet of pay sand. The lower productive zone (700-800 feet below the upper pay) has an average thickness of 25 feet of pay sand. Average permeability of the matrix rock of the two zones is less than one millidarcy and average porosity is 12 percent.

The tracer survey was made in the Aldwell area, Block B., L. & S.V. Survey, Reagan County, Texas. The central well of a nine-spot group was selected for injection, with three production wells on each side drilled on 80-acre spacing as shown in Figure 1. Four additional wells at a greater distance from the injection well also were used as monitoring points.

The injection well was completed in the lower Spraberry formation at a depth of 7,200 feet, with the upper formation packed off for the duration of the tracer survey. Of the 12 production wells selected as monitoring points, 11 produced from both zones and one produced from the lower zone only. Four of the wells produced oil by pumping; gas lift was used to lift the other eight wells. Approximately 15 barrels of oil and 750 Mcf of gas were produced daily from each of the 12 wells during the test. Essentially, no water is produced from the lower Spraberry formation; the upper zone produces an estimated 10-30 percent water.

Test procedure and results. Proportionally tagged gas with a specific radioactivity of 0.03 microcurie per cubic foot was injected for a period of 12 weeks at a rate of 500 Mcfd. Injection pressures ranged from 850 to 1,000 psi at a temperature of 150° F. At the beginning of the thirteenth week, a slug of two curies was injected. At the beginning of the fourteenth week, a slug of one curie was injected. Radiation monitoring was continued until gas injection was

Many geologic factors govern waterfloods

GEOLOGISTS should acquaint themselves more fully with waterflood and other combined engineering—geological operations, especially since exploration is generally curtailed

RESERVOIR ENGINEERS engaged in waterflood work should be sure that all pertinent geological considerations are duly weighed. Here are some of them:

- **Subsurface relationship between aquifer and producing horizon. Was natural water drive effective? If not, why not?**
- **Do thin, highly permeable zones correlate across the field? They can impair success of a waterflood**
- **Are swelling clays present in the producing formation?**
- **Are available ground water sources sufficient to maintain the flood?**

By Hal W. Yeager, Jr.
Consulting Petroleum Engineer, Wichita Falls, Texas

WATERFLOODING HAS BECOME BIG BUSINESS and is attracting many operators. Despite improved engineering technology, some failures are still reported. Such failures are usually found to have been caused by inadequate understanding of important factors involved in achieving an economically successful flood. Besides hurting the operator, a waterflood failure hurts the industry since it may influence others against undertaking similar ventures. Oil that otherwise would be recovered is lost.

Primary consideration in a waterflood prospect is to determine the original oil content of the reservoir and to estimate the quantity of oil that may be recovered at the end of the flood. Answers to these questions coupled with cost studies determine the economic worth of a particular waterflood project.

Increased interest of geologists in waterflood problems is a recent, significant development. Until recently, geologists engaged almost exclusively in exploratory work. Today many work closely with petroleum engineers in designing and conducting waterflood operations. Geologists help determine factors affecting oil accumulation, reservoir configuration, and reservoir drive mechanism; they prepare geologic structure and isopachous maps, cross-sections, core analyses, and undertake other studies to determine the likelihood of success of a prospective waterflood.

Many fields with associated aquifers may benefit from natural expansion of the aquifers to such a degree as to effect complete water drives, or built-in waterfloods. Obviously, fields with strong water drives are of little value for secondary recovery by waterflooding.

Solution gas-drive fields. The other extreme is the lenticular reservoir without an underlying aquifer or free gas cap above that produces oil by means of the expanding gas dissolved in the crude. This is the reservoir that most readily lends itself to profitable waterflooding, because at economic primary depletion the residual oil content of this reservoir may be as much as 85 percent of the total original oil content. On the other hand, the strong water drive fields may contain less than 25 percent of the original oil in place at primary depletion.

Sometimes a reservoir may be produced in such a manner as to prevent the effective development or dissipation of more efficient naturally occurring producing mechanisms. A reservoir may be in direct contact with an aquifer and yet fail to receive significant benefit from the natural expansion of the aquifer. It is important to determine why such an aquifer did not effect greater oil recovery. Was it caused by a specific geological configuration and characteristics, or excessive withdrawal rates? The geologist and engineer must collaborate in answering such questions.

Free gas caps present a unique problem to waterflooding because of the inherent hazard of (1) oil migration into the shrinking gas caps and/or (2) thiefing water into dry gas caps. It may be necessary to fill a gas cap with water or gas in the initial phases of water flooding operations to overcome these hazards.

In some lenticular reservoirs a geologic structure map drawn on the top of the oil-producing sand may indicate a structural trap. Closer study, using geologic cross-sections might show this same reservoir to be a series of sand members that thin and disappear at the edges—hence, stratigraphic development actually caused oil entrapment. Possible erratic currents and other environmental conditions at the actual time of sand deposition should be considered.

Thus, the geological configuration and driving mechanism as they affect the oil content and recovery largely determine the feasibility of a waterflooding prospect.

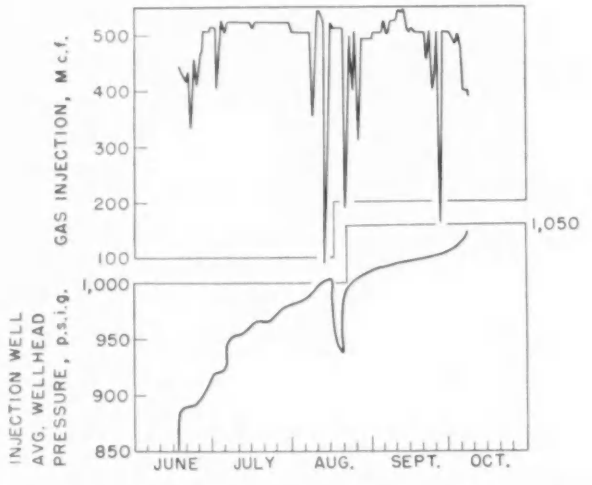


FIGURE 4—Gas injection rates were essentially constant except for compressor shutdown periods and wellhead pressures increased at a fairly constant rate. This indicates there was no direct fracture communication between wells.

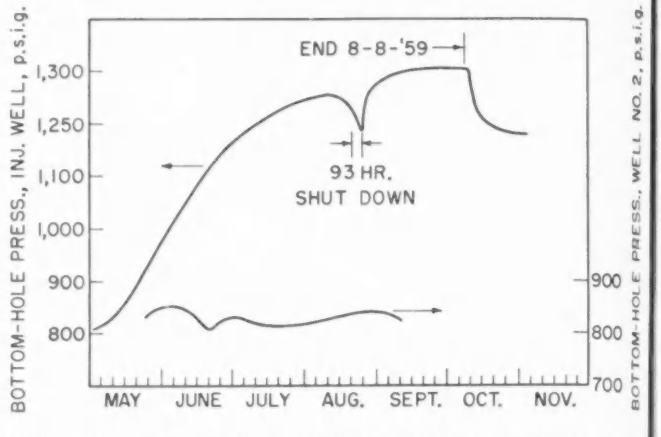


FIGURE 5—Plot shows relationship between injection well BHP and well 2 BHP. Similar results were obtained from six other producing wells. Again, results indicated no direct communication between the injection well and producing wells.

halted at the end of the sixteenth week.

As indicated in Figure 2, tracer was detected 64 days after injection commenced through increased radioactivity of the gas produced from well 2, 1,884 feet northeast of the injection well. The magnitude of increase in radioactivity was not great and increases were cyclic, occurring at approximate intervals of about one week.

Increased radioactivity was detected at well 9, 4,161 feet southwest of the injection well, 103 days after injection was started. As shown in Figure 3, radioactivity increases at this well also were cyclic.

No radioactivity increases were detected at any of the other 10 wells monitored during the tracer survey. The cyclic nature of tracer appearance was attributed to the necessity for overcoming the varying hydrostatic head of oil in the well and to the appreciable difference in effective permeability of the principal and cross fracture systems. Regularity of radioactivity increases at well 9 may be explained by the fact that it probably is closer to the more effective fracture line than well 2. Apparently, neither well intersected the same fracture plane as the injection well.

Prior to injection, it was predicted that the tracer would first appear in well 2, because of its proximity to the predicted fracture orientation line and relative closeness to the injection well (Figure 2). The dashed line in Figure 2 (N57°E) shows the predicted fracture orientation on the basis of core examination. Information obtained informally from a concurrent tracer test made with stable (non-radioactive) gas on a nearby property indicated that the line of fracture permeability on that property probably was N48°E (solid line, Figure 2). One production well on that property evidently did intersect the same fracture plane as the injection well.

In the radioactive-krypton tracer test, the fractures at the injection well apparently did not intersect any production well. Thus, the line of fracture orientation cannot be located precisely from the data obtained. However, it is probable that the line is no more than a few degrees off the solid line shown in Figure 2.

During the tracer survey, precise records were kept of injection rates and pressures, and bottom-hole pressures were measured in the injection well and in some of the production wells to determine whether pressure changes might indicate direct fracture communication between wells. Figure 4 is a plot of the rate of gas injection versus injection wellhead pressures.

Figure 5 is a plot of the BHP in the injection well and in well 2. BHP of the injection well increased steadily, while the BHP of well 2 varied with time. However, the magnitude of variations were no greater than variations of individual pressure measurements during a 72-hour period. Therefore, it was concluded that no direct communication existed between this well and the injection well.

Conclusions. The radioactive gas tracer survey corroborated the early prediction as to the general line of fracture orientation in the lower Spraberry reservoir in the area of the tracer tests. This information will be used by the operators of the planned water injection unit in spacing and locating water input wells to give the greatest sweep efficiency of injected water and thereby obtain maximum oil recovery possible through water injection.

The experimental tracer gas injection and detection techniques and instruments used[4] were satisfactory. Both detection and injection units operated continuously for extended periods of time with only slight attention and minimum maintenance. The survey demonstrated that radioactive inert gases (such as krypton-85 or xenon-133) can be used to trace the flow of fluids in petroleum reservoirs with minimum loss through solution in reservoir fluids (chemical reactions and adsorption being no particular problem). Also inert radioactive gases should be applicable in tracing reactions and flow in other stimulative production methods, such as pressure maintenance by gas injection, miscible-phase or solvent injection, or in-place combustion.

LITERATURE CITED

[1] Barfield, E. C., Jordan, J. K., and Moore, W. D. An Analysis of Large-Scale Flooding in The Fractured Spraberry Trend Area Reservoir. Jour. Petrol. Technol., Vol. 11, No. 4, April 1959, pp. 15-19.

[2] Texas Petroleum Research Committee Bulletin 15, October 1951.

[3] Watkins, J. W., Mardock, E. S., Armstrong, F. E., and Heemstra, R. J. Waterfloods Benefit by Radioactive Tracer Techniques. The Mines Magazine, Vol. 47, No. 10, Oct. 1957, pp. 87-91.

Sand uniformity and texture. The term "sand uniformity" is a contradiction in terms. Oil sands are not uniform or homogeneous. They are highly heterogeneous. The degree to which a heterogeneous sand approaches homogeneity or uniformity, however, is extremely important in waterflooding calculations. Actual grain size and grading, shape of grains, character and amount of cementing material, and pore pattern tortuosity determine porosity and permeability of a sand and degree of homogeneity.

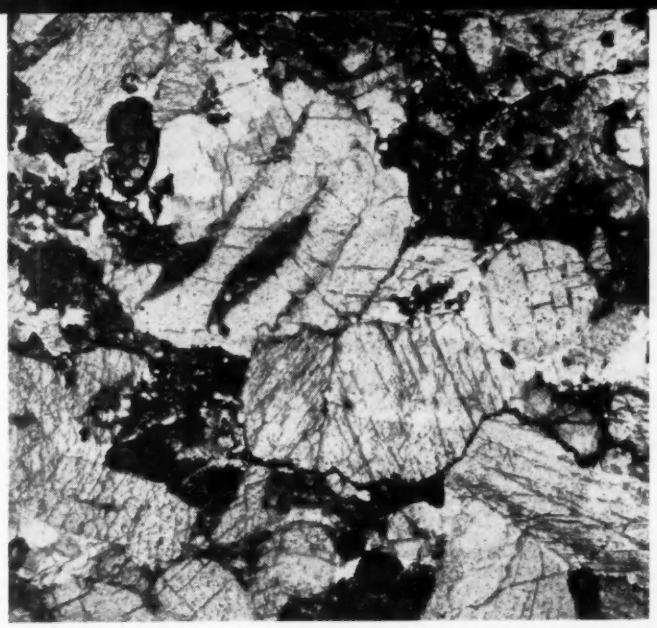
The permeability profile, as determined from core analyses, is a most valuable and practical tool for determining relative homogeneity. Generally the greater the degree of uniformity exhibited in a profile the greater will be the sweeping efficiency of the driving medium in displacing oil from the reservoir. However, there are many instances of highly successful waterflooding in sand bodies with relatively poor permeability profiles.

This brings up an important geological consideration of the profiles. From an oil recovery and sweep efficiency aspect the degree to which a particular profile correlates from one well to another is more important than the exact shape, dimensions, or capacity of that particular profile. A thin zone of high permeability extending from one well to another constitutes a *hazard* to waterflooding efficiency by thiefing water, whereas an irregular profile correlation may actually result in improved oil recovery with effects of capillarity.

Permeability. The actual value of permeability is not too important in waterflooding insofar as sweep efficiency is concerned. It is generally thought that sands with relatively low permeability waterflood with greater sweep efficiencies. The reason lies in the fact that the tighter sands generally give up less oil during the primary life and therefore usually have a greater percentage of the original oil in place remaining at primary depletion. It was formerly supposed that the oil fails to bank ahead of the driving water front in the higher ranges of permeability. Most experienced waterflooders now feel that is a function of oil saturation as related to permeability and porosity rather than permeability alone.

Some reservoirs occasionally exhibit significant permeability changes with direction. The Bradford Third sand of Pennsylvania, Burbank fields of Oklahoma, and shoestring sands of Kansas exhibit directional permeability or anistropy parallel to bedding planes. This geologic consideration is usually not too significant and is not ascertained until actual waterflooding is in progress.

Composition of reservoir matrix. Considerable laboratory evidence exists indicating that the mineralogical composition of the reservoir rock and chemical composition of the crude oil itself affect the amount of oil recovered by waterflooding. For example, quartz and calcite, two very important constituents of common petroleum reservoir rock, are generally hydrophylic in nature—that is, preferentially wet by water rather than oil. However, under certain conditions of crude petroleum composition, quartz and calcite can both become hydrophobic, or preferentially oil wet. Thus, it could be shown that the irreducible minimum oil saturation by water flushing action could vary significantly, depending upon whether the reservoir rock was hydrophylic or hydrophobic. It is suggested that most oil sands are naturally hydrophylic, and hydrophobic, or oil wet sands, are rare.



Northwest Geological Service photo

Reef facies present distinct problems in waterfloods. Grain sizes and shapes, type and amount of cementing material, pore pattern tortuosity, etc. are highly variable. Overall sweep efficiency is more important than structural configuration. Lack of bedding planes may be a help, not a hindrance. H_2S is more prevalent in limestone than in sandstone. Some reefs (e.g., Sacroc operation, West Texas) are being waterflooded.

The type and abundance of clay mineral occurrence in petroleum reservoir rock is very important in waterflooding. The montmorillonite, bentonite, and illite clay groups tend to swell and deflocculate in the presence of fresh water. This in turn may cause a reduction in the effective permeability of the sand. Clays are extremely complex in molecular construction and behavior. Much more research is needed on behavior of clays and related effects on petroleum reservoirs. Total oil recovery by primary and secondary methods have been adversely affected by clays present in petroleum reservoirs.

The presence of coal streaks in an oil sand is always a hazard to waterflooding. Coal is weak and brittle, and readily ruptures under relatively small hydraulic pressure; thus a coal streak could easily thief most of the injected water which would bypass the oil sands.

Depth. Reservoir pressure is usually a function of depth. Increasing depth means increasing pressure and gas solubility. Thus, with increasing depth a reservoir usually produces a greater percentage of the original oil in place with the consequent reduction in waterflood oil recovery. On the other hand greater depth means that greater injection pressures and injective capacity can be obtained. Thus, with greater injective capacity, well spacing and patterns can be enlarged.

It has been found in waterflooding operations that a critical injection pressure can be reached, above which *hydraulic fracturing* and consequent oil bypassing or channelling occurs. Critical pressure varies from one sand to another and from one area to another, but it is usually in the range of 1.0 to 2.0 psig per foot of depth. The critical pressure of any injection well can easily be determined by plotting injection rate versus pressure. Above the critical pressure the injection rate increases much faster with increments of pressure.

Extremely shallow oil sands have the disadvantage of correspondingly low critical injection pressures, often too low to permit economically profitable waterflooding.

Injection pattern. Geological considerations are quite important in determining the waterflooding injection pattern. The most commonly employed patterns are the conventional five spot, peripheral type, and line drive. There are many variations or modifications of these basic patterns. The peripheral pattern is perhaps the most efficient sweep in a theoretical sense. However, other parameters must be considered.

Structural relief or dip may influence injection pattern selection. It is often attractive to inject water into an existing partially effective aquifer to increase its effectiveness or rate of encroachment.

Downdip-side injection may backfire. In this connection, however, there is a widespread popular misconception about the location of the injection wells. Many operators inexperienced in waterflooding insist on injecting water in the downdip side of a reservoir irrespective of over-all sweep efficiency considerations. They believe that injected water and oil quickly reach equilibrium conditions in a reservoir, with the oil floating on top of the water. Actually, because of capillary action and nature of the porosity and permeability systems, *eons* of time are required for such equilibrium to be achieved. The act of water flooding, usually requiring five, 10, perhaps 20 years, is practically instantaneous compared to the time required for the reservoir fluids to segregate by gravity and density variations.

Effect of dip. It can be shown mathematically that sweep efficiency is not significantly related to structural dips of the reservoir at dips up to 30 degrees or more. Common structural dips are five degrees or less. Thus, paramount consideration in pattern selections is over-all sweep efficiency rather than structural position.

The Sacroc waterflood operation is a striking example of this rule. Rather than injecting water into the structurally low edge areas of the reservoir, it is injected into the structurally highest wells in the field that extend down the apex or ridge of the reef development. This injection program was chosen because it resulted in more positive injection into a maximum reef section and the effects of lenticularity will be minimized.

Water supply. A waterflood project must have a suitable and adequate water supply. Most areas have sufficient sources at reasonable depths.

Several geological considerations influence the selection of a water supply. Most important is the possible size of the aquifer with respect to the ultimate water requirements. Every effort should be made to study the particular aquifer in mind to make certain it is as extensive as possible. A water well may decline in productivity much faster than a comparable oil well. Thus, a suitable aquifer should be many times greater in size than the petroleum reservoir being flooded.

The following simple rule of thumb for water supply well productive capactiy calculations may be used: one supply well per 160 acres will produce one barrel of water per foot of depth per 100 feet of sand. Thus, a 100-foot thick sand section at 1,000 feet of depth should produce 1,000 barrels per day. This rule would not apply, of course, to fractured systems.

Other factors may influence the selection of a water supply. The hydratable clay content may determine whether or not fresh water can be used advantageously. It may be that while one reservoir could actually lose 20 percent of its permeability by clay swelling and still have sufficient permeable capacity, another reservoir might be at a serious handicap by losing only 10 percent to 15 percent of its natural permeability which would preclude the use of fresh water.

Compatibility of the natural interstitial water and the extraneous water supply is an important engineering aspect of a waterflood. Incompatible waters increase treating costs and danger of plugging injection wells at the sand face. Usually, brines in sandstone reservoirs vary in mineral constituents in proportion to depth. Thus, the greatest degree of compatibility can usually be expected from two brines located at approximately the same depth.

Also salt waters from sandstones are generally sweeter and less troublesome than the limestone waters. Limes contain troublesome hydrogen sulfide more often than sands.

This article is based on a paper presented at the Southwestern Regional Meeting of The American Association of Petroleum Geologists, Lubbock, Texas, Oct. 8-10, 1959.

WORLD OIL's readers are invited to notice an interesting parallel between the author's comments, and certain others contained in the 1960 and 1959 International Outlook issues (August 15):

Yeager (on page 47): "A thin zone of high permeability extending from one well to another constitutes a hazard to waterflooding efficiency by thiefing water, whereas an irregular profile correlation may actually result in improved oil recovery . . ."

WORLD OIL August 15, 1960, page 216, regarding a water injection-pressure maintenance project at Abqaiq field, Saudi Arabia: "The rock is primarily a pellet-type calcarenite, with some oolites and dolomitization being present. *There are no continuous bedding planes. The highly successful pressure maintenance programs* at Abqaiq are being carefully watched . . . "

WORLD OIL August 15, 1959, page 144, regarding gas injection in the Bolivar Coastal fields in Venezuela: "*Scattered shales within the producing Eocene sandstone* have not prevented nearly vertical segregation of gas, while permitting low ratio production through isolation of the upper portion from the producing interval. Success of the operation has exceeded previous expectations."

The worldwide similarity of experience with irregular bedding planes as to their effect on secondary recovery operations supports the contention of the WORLD OIL staff that technical articles based on field experience are in effect international articles, whether the experience described is gained inside or outside of the United States (Editor's note).

How different mud additives affect R_m-R_{mf}-R_{mc} ratios

Logging tool is separated from the virgin formation by mud column, mud cake on borehole, filtrate mud, invaded zone and a low zone

By Dr. Hamilton M. Johnson
Professor of Geology and Geophysics
Tulane University, New Orleans

THE TERM "electric logging" has come to mean a measurement made in a borehole of the electrical properties of the rocks surrounding the borehole. These measurements must be made in uncased hole, for metallic casing provides complete shielding between the measuring electrodes and the formations. However, this is the only material which can completely prevent electrical measurements, for electric logs are now recorded in holes filled with fresh-water muds, concentrated salt-water muds, oil-emulsion muds, oil, or even in empty holes.

The complexity of muds currently used to overcome problems presented by the much higher temperatures and pressures of deeper drilling has introduced new problems in formation evaluation. The downhole logging tool is surrounded by mud if the tool hangs freely in the hole, or it is

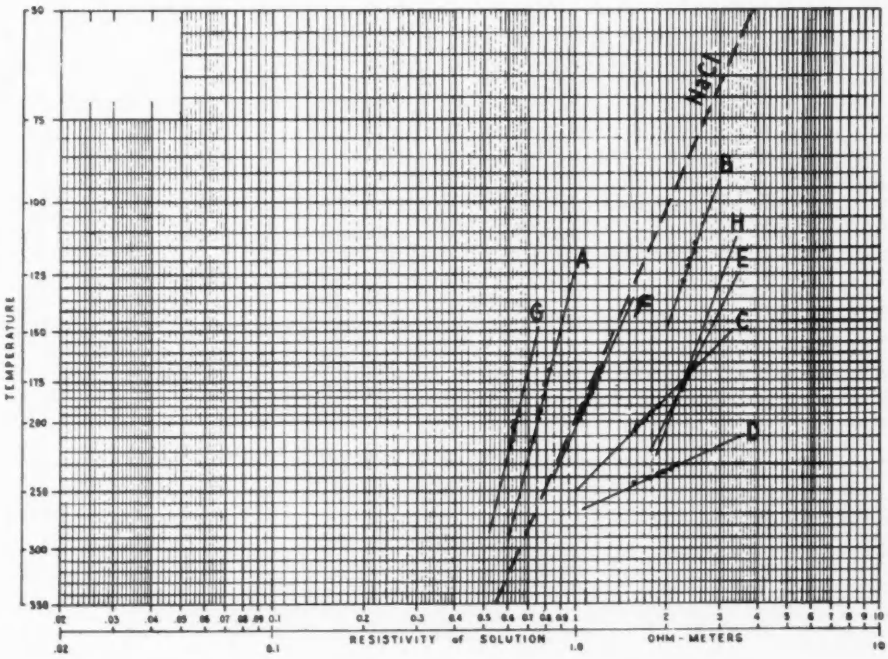


FIGURE 1—R_m-temperature relationship in oil-emulsion muds.

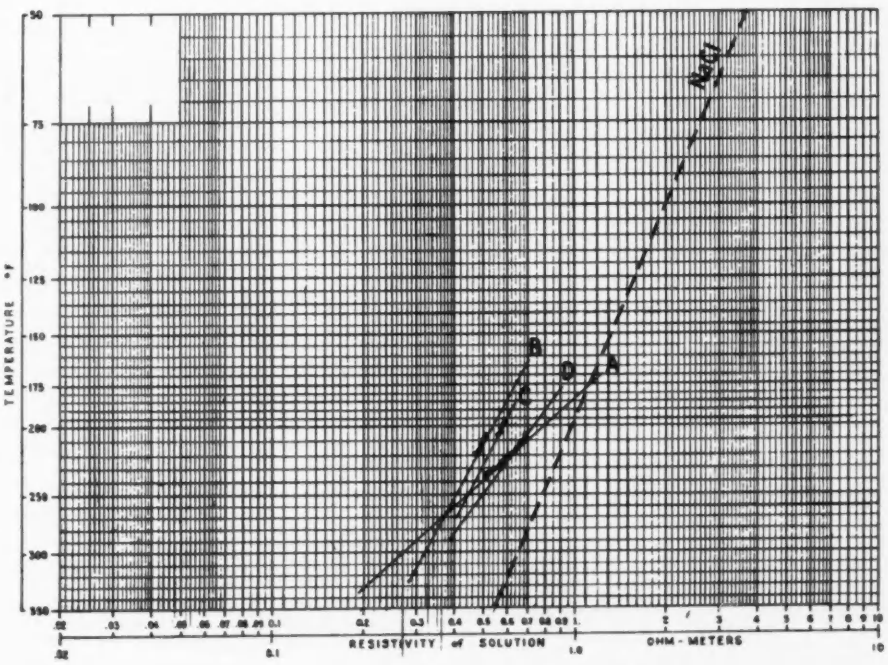


FIGURE 2—R_m-temperature relationship in gypsum-base muds.

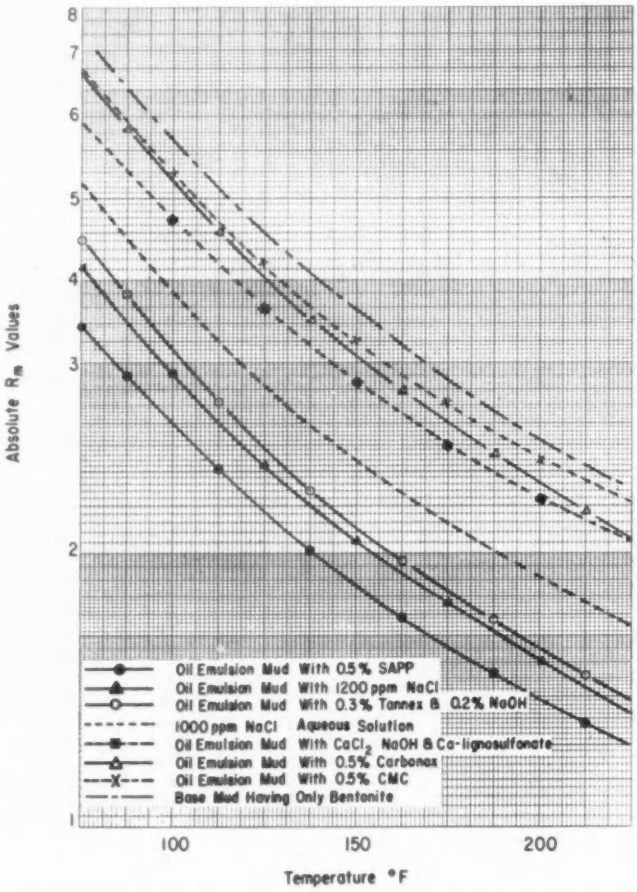

Absolute R_m Values
Temperature °F
Oil Emulsion Mud With 0.5% SAPP
Oil Emulsion Mud With 1200 ppm NaCl
Oil Emulsion Mud With 0.3% Tannex & 0.2% NaOH
1000 ppm NaCl Aqueous Solution
Oil Emulsion Mud With $CaCl_2$ NaOH & Ca-lignosulfonate
Oil Emulsion Mud With 0.5% Carbonex
Oil Emulsion Mud With 0.5% CMC
Base Mud Having Only Bentonite

FIGURE 3—R_m-temperature relationship in synthetic muds with various additives.

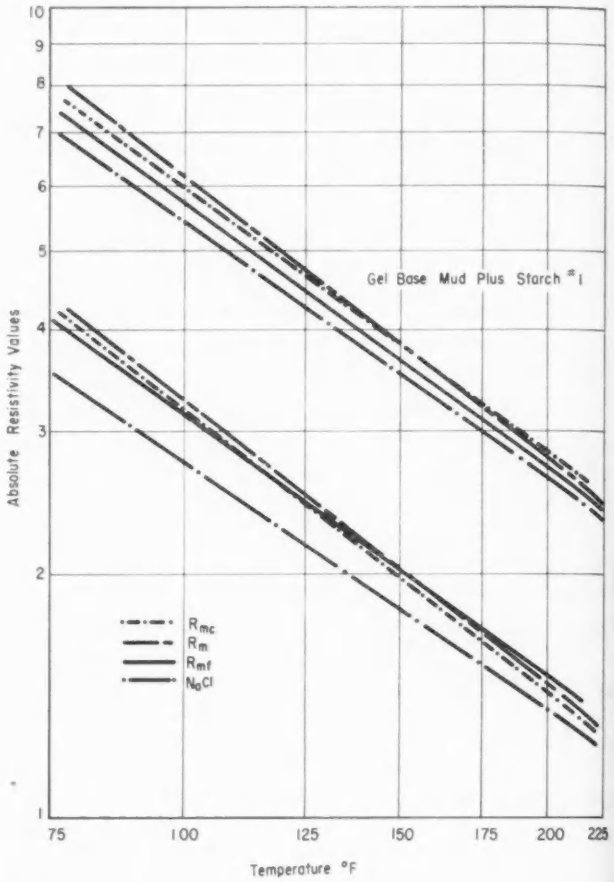


FIGURE 4—R_m, R_{mf}, and R_{me} temperature relationships in two synthetic starch base muds.

pushed against the mudcake if the tool is of the contact type. Therefore, the point of measurement (the electrode system) is necessarily separated from the formations by mud or mudcake. Also, the formations proper are partially or wholly contaminated by filtrate from the mud.

At best, there are certain mud-affected cylinders surrounding the logging tool and separating it from the virgin formation. These cylinders include:

1. The mud column.

2. Mudcake on the borehole wall.

3. The flushed zone where all removable fluids have been replaced by mud filtrate.

4. The invaded zone in which only partial replacement has been effected.

5. A "low" zone which sometimes occurs when formation water may have been concentrated in a saturated oil sand by the flushing action. From this resumé, it is obvious that accurate measurements of the resistivity of the mud column (R_m), of the mudcake (R_{mc}) and of the filtrate from the mud (R_{mf}), are basic to optimum use of recorded logs.

How is R_m measured? The primary measurement must be a value for R_m. A representative sample of mud in the hole at the time of logging is caught from the flow line just before removing the drill pipe from the hole. This sample then is placed in a standard four-electrode resistivity cell and the resistance across a unit volume (thus the "resistivity") measured.

The resulting measured value, together with the temperature at which it was measured, represents the mud resistivity for this particular electric log. Since the resistivity must be used at formation temperature rather than surface temperature, a resistivity-temperature conversion is made through use of the standard NaCl temperature-resistivity chart from the International Critical Tables.

Since muds are becoming so complex, the question immediately arises as to the error involved in using the NaCl chart for conversion to formation temperature. A rough check of this point was made in the field by the author.[1] The value for R_m obtained from a log made with the collapsed microsonde was compared with the R_m value measured at the surface in a resistivity cell and corrected to downhole temperatures using the NaCl chart.

A plot of data from 272 logging operations showed a scattering of points so great that any points of agreement were judged accidental. The discrepancies were thought possibly attributable to the method of correction to formation temperatures, since muds were all of the oil emulsion type and it was not known

WHEN CASING MUST BE CENTERED

THE LARKIN DOUBLE BOW DOES IT BEST

FIG. 905 LONG LOK-ON

Highest centering strength • Lowest permanent set • Five ranges for easy starting and maximum efficiency in any casing/hole size combination • Available . . . "Through Your Supply Store."

LARKIN PACKER COMPANY

DIVISION KOEHRING COMPANY

WAXAHACHIE, TEXAS

LARKIN LEADERSHIP HAS BEEN EARNED BY YEARS OF DEPENDABLE PERFORMANCE

LARKIN

...Through Your Supply Store

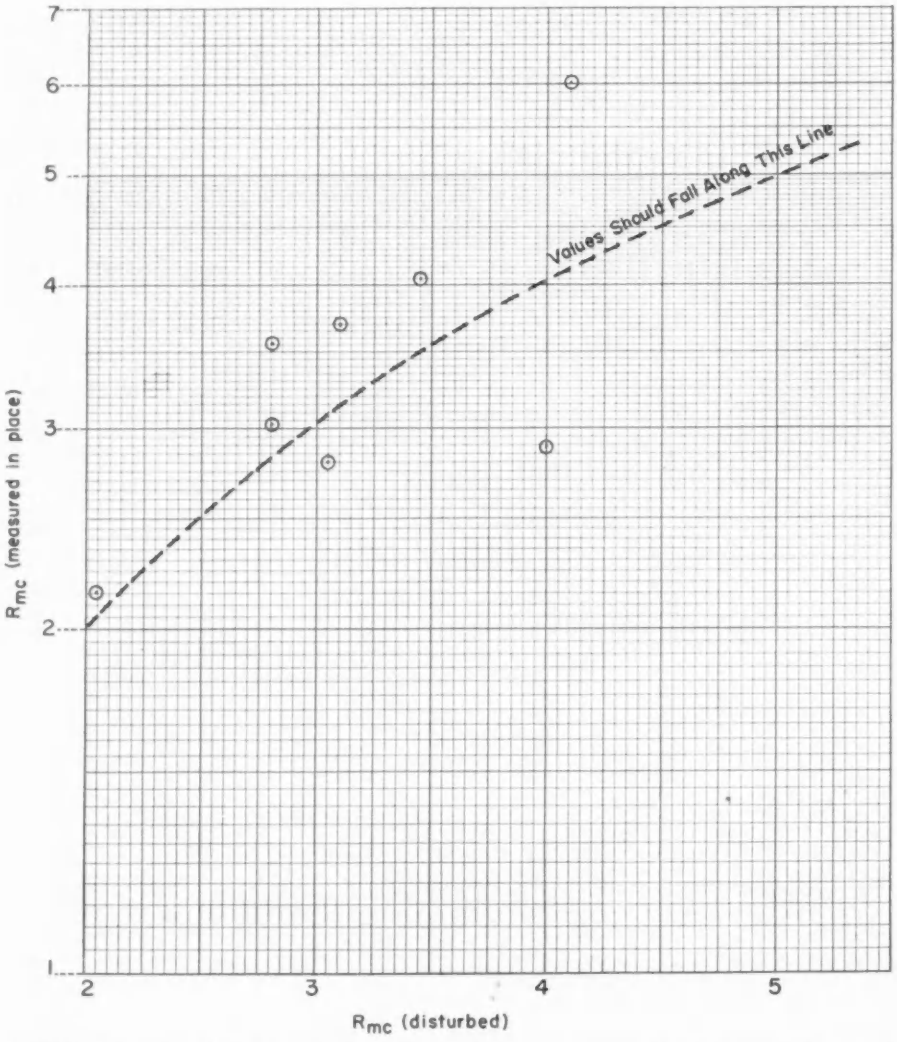


FIGURE 5—Here is comparison between the R_{mc} measured in place as deposited and R_{mc} measured after mudcake has been disturbed.

whether the use of the NaCl chart would yield suitable correction factors for them.

What is "oil emulsion" mud? The term oil emulsion mud does not constitute a specific description for a definite drilling fluid. It simply implies that water forms the continuous phase and has oil emulsified into it. Within this general classification, variables may include the type of oil, emulsifier, thinners, gels, weighting material, fluid-loss control agents, decontaminants and the concentration of each present in the mud. The wide range of these may be seen in Figure 1, which shows field measurements of R_m variation with temperature for various oil emulsion muds. No effort was made to separate the data with regard to any other characteristic.

Values in Figure 1 were obtained by recording a mud log with the collapsed microsonde on a very sensitive scale through thousands of feet of open hole. The reliable figures obtained then were plotted against temperatures estimated from the thermal gradient measured in the borehole at time of logging.

Figure 2 was prepared in the same way except that the four wells shown were all drilled with a gypsum base oil emulsion mud. These figures indicate that the temperature-resistivity correction chart for NaCl holds fairly well for some oil-emulsion muds but not at all for others. The same apparently is true of the gypsum base muds. It also means that the complexity of muds now available is going to force a move from the "horse-and-buggy days" of analysis to a more scientific approach of studying all factors involved.

In view of the field evidence, Lynn[2] began a series of laboratory experiments on the variation of mud resistivity with temperature wherein the effect of one additive at a time could be considered on a standardized gel mud.

Figure 3 has been modified from some of his measurements and shows that, while the general slope of all relationships appears roughly the same, exact values may vary by as much as ten percent over a temperature range of 75°-225° F.

The earliest and still by far the most common method used to determine R_{mf} and R_{mc} is to apply some ratio of R_{mf}/R_m and R_{mc}/R_m. Previous work by the author[1] on field muds and by Lamont[3] on laboratory prepared muds indicated that the accuracy of values for R_{mf} and R_{mc} obtained in this way was quite poor. Average relationships were found which differed from those suggested by the service companies but which agreed quite well between the two:

Johnson $R_{mf} = 0.87\ R_m$ and
$R_{mc} = 1.11\ R_m$
Lamont $R_{mf} = 0.88\ R_m$ and
$R_{mc} = 1.31\ R_m$

It should be emphasized that these are only approximations and may actually introduce a large error, as is obvious from their published graphs. In fact, the service companies recommended that this method (graphical) be avoided whenever possible and that measurements of R_{mf} and R_{mc} be made on each individual mud at the time of logging.

The field measurement of mud resistivities often used by many of the service companies now provides values for R_m, R_{mf} and R_{mc}. The R_m value still is measured as described previously and should be a good measurement if the cell has been thoroughly cleaned since previous use, if the oil is well emulsified (in the case of oil-emulsion mud), and if the operator is careful.

A sample of the mud then is placed in a filter press, pressure applied, filtrate forced out and a cake formed on filter paper. The filtrate resistivity is measured in a cell just as was R_m. The cake is then scraped from the paper and smeared across an electrode system whereby its resistivity may be measured.

Again, previous work[1] has shown that these meaurements might not be without fault, particularly in the rearrangement of the solid particles in the mudcake when moved from the

Text continued on Page 62
Charts on Pages 54, 58 and 59

HUMBLE BREAXIT®

Gets maximum pipeline oil from any well

To get the greatest amount of salable oil from your production, there are many *different* Humble BREAXIT emulsion breakers . . . each designed for efficient treatment of a different concentration of water in the oil. Result?

Users of these specialized BREAXIT formulations report important savings through lowered treating costs and increased recovery.

Find out which BREAXIT will be most profitable in your production. Ask Humble to have its engineers make on-the-lease tests of your emulsions. For more information about BREAXIT, see your Humble salesman, or contact Humble Oil & Refining Company, Houston, Texas.

America's Leading ENergy COmpany

HUMBLE

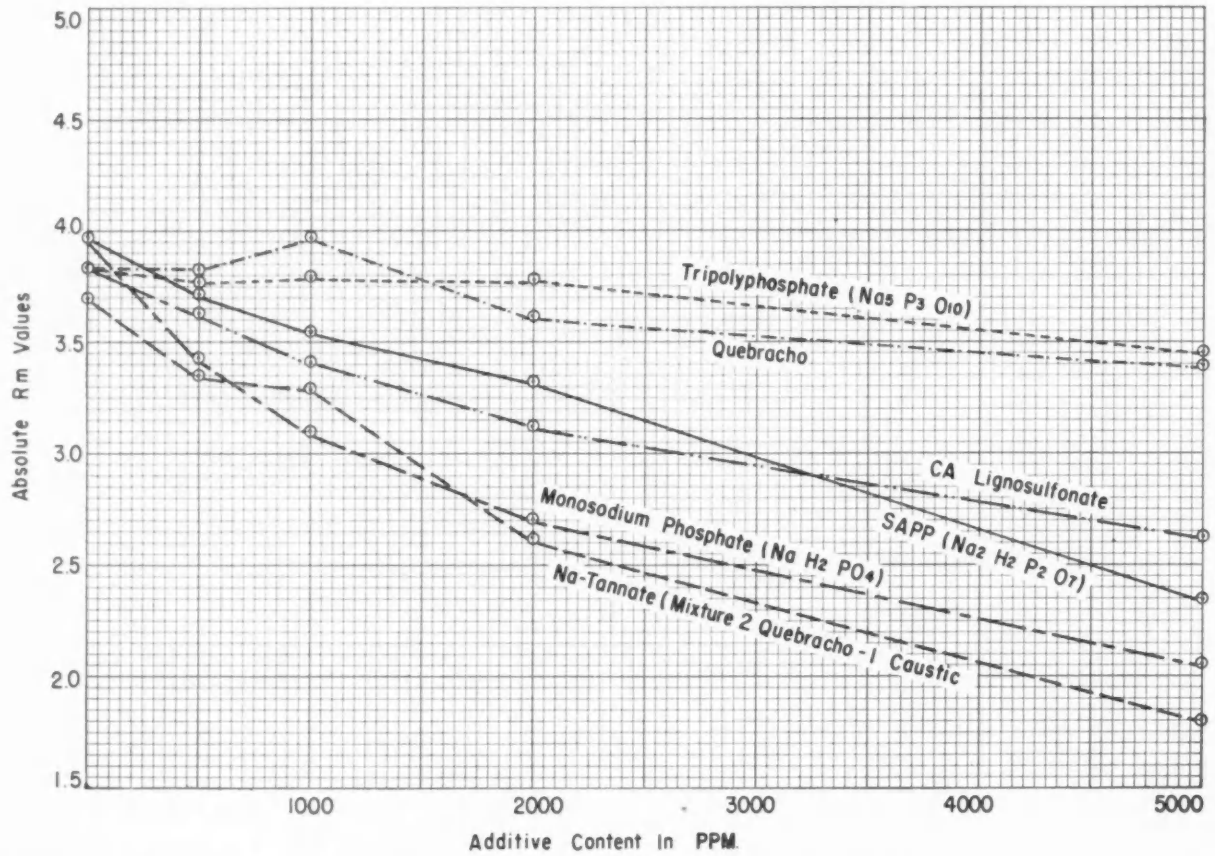


FIGURE 6—Thinner-R_m variation with increasing concentration of additives. All measurements are recorded at 75° F.

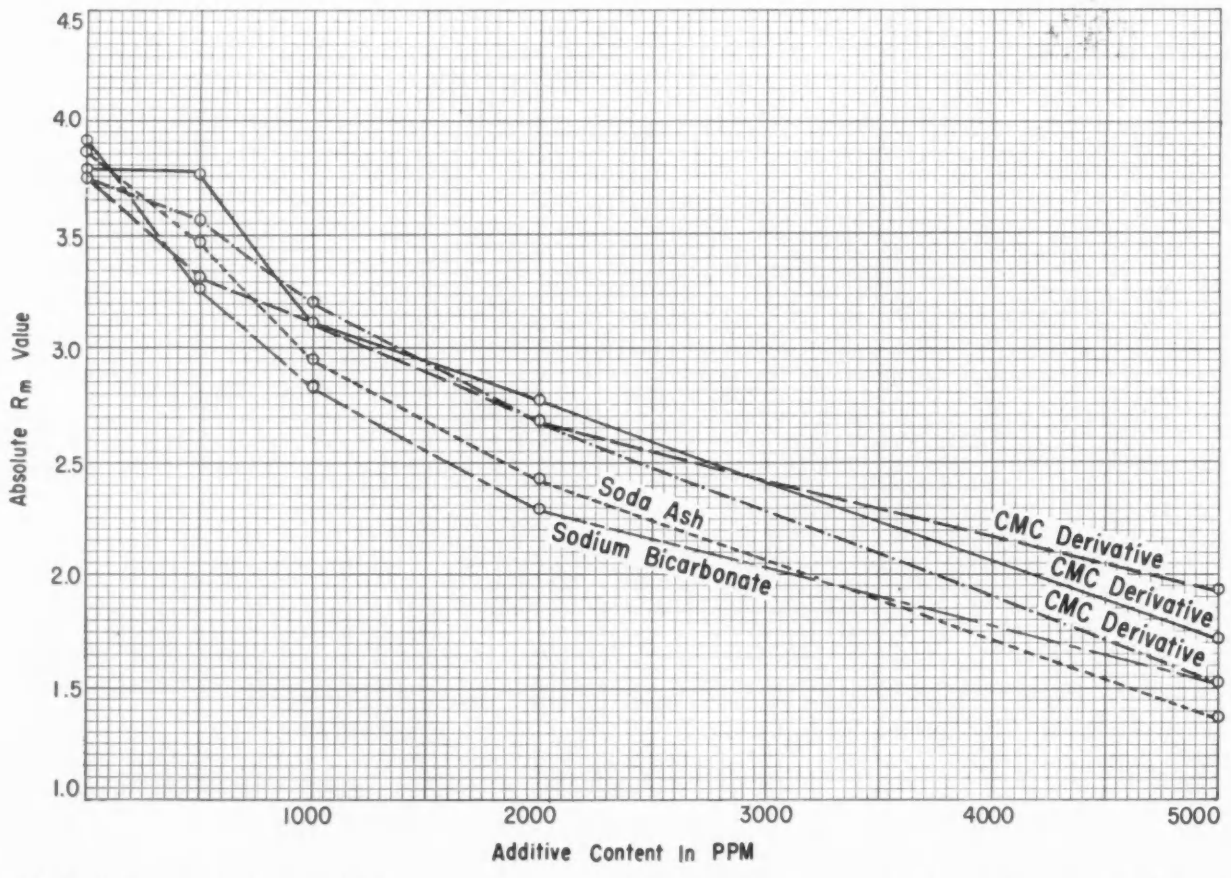
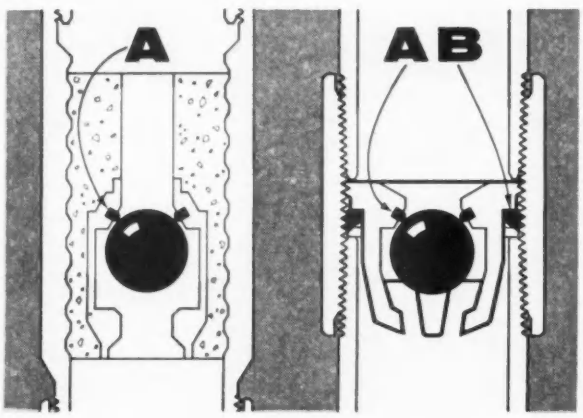


FIGURE 7—R_m of different fluid-loss control agents and decontaminants vary with increasing concentration of additives. Measurement recorded at 75° F.

Continued on Page 58

Important new design features bring improved performance to insert equipment!

In wells of moderate depth these new insert valves offer convenience and economy. They provide many of the features that have made Baker floating and fill-up equipment so dependable and so widely accepted. Extensive testing by Baker engineers revealed that insert equipment must overcome several inherent difficulties if it is to perform effectively. These tests further indicated that valves already on the market did not adequately cope with the problems. How Baker engineers successfully designed these new insert valves to overcome these problems, and to deliver superior performance, is described below.

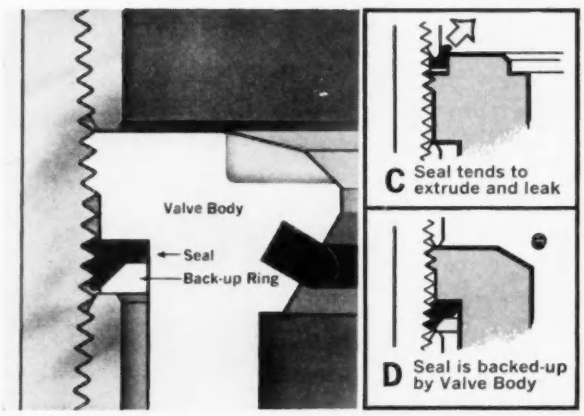


MUST HOLD PRESSURE AT TWO POINTS

In a conventional Baker collar the valve is surrounded by drillable concrete which not only holds the valve in place, but also blocks fluid passage around the outside of the valve. The ball-check valve (Seal A) is thus the only seal required. An Insert Valve, however, does not have this concrete back-up and must provide, in a *one-inch space* (Seal B), all the resistance to pressure provided by a *foot of concrete* in conventional equipment. And, since the pressures involved can reach several thousand p.s.i., the proper location and design of this seal are of vital importance.

WHY LOCATION OF THE SEAL IS IMPORTANT

A seal so located that it relies upon the pin above it for a back-up is not going to be able to stand pressures from below—especially in lighter-weight casing. Drawing "C," below, indicates the way such a seal may extrude and leak. Only a seal located so that it is backed-up by the metal of the valve itself can have a chance of staying on through completion of the job (Drawing "D").

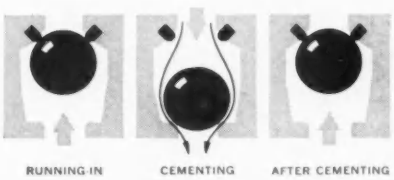


WHY DESIGN OF THE SEAL IS IMPORTANT

Exhaustive testing proved to our engineers that even a seal properly located won't last through the job unless it is designed like the one illustrated above. Notice that the underside of the seal is tapered and that it is *backed-up by a metal ring with a matching taper.* This is important for two reasons: 1) It bottles up the seal to make it effective not only against back-pressure, but also against pressure from above when a follow plug is bumped; and, 2) since the distance between made-up pin ends varies, it lets the valve seal-off in the widest possible range of casing weights without interfering with complete joint make-up.

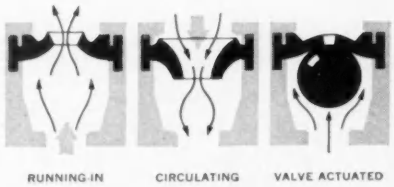
CONSULT YOUR BAKER REPRESENTATIVE

He will gladly explain the important differences in available insert equipment, and provide you with practical information on its use in your specific well program.



The Floating Ball is the ideal check valve

Running-in: Floating ball maintains a leak-proof back-pressure seal. No springs, guides or hinges. Cementing: Ball is never stationary long enough to be eroded or cut by slurry. After cementing: Ball floats up to reseal the instant pumping stops.



How Variable Valve controls casing fill-up

Running-in: Opening in the diaphragm responds to pressure changes, giving automatic control of fill and maximum relief from pressure surges. Circulate: As desired. Valve Actuated: By pumping ball through diaphragm to provide check valve.

BAKER

BAKER OIL TOOLS, INC.
HOUSTON
LOS ANGELES · NEW YORK

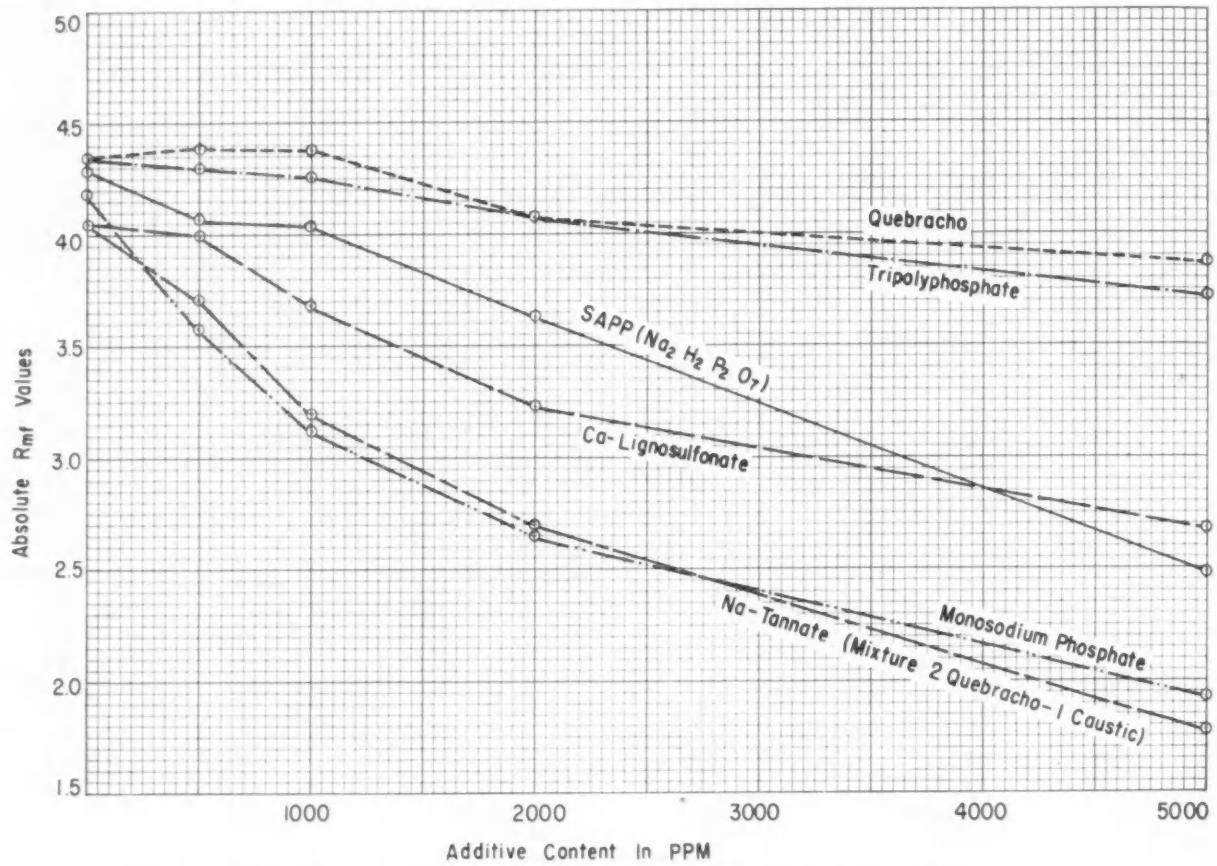


FIGURE 8—Thinner-R_{mf} relationship with increasing concentration of additives.

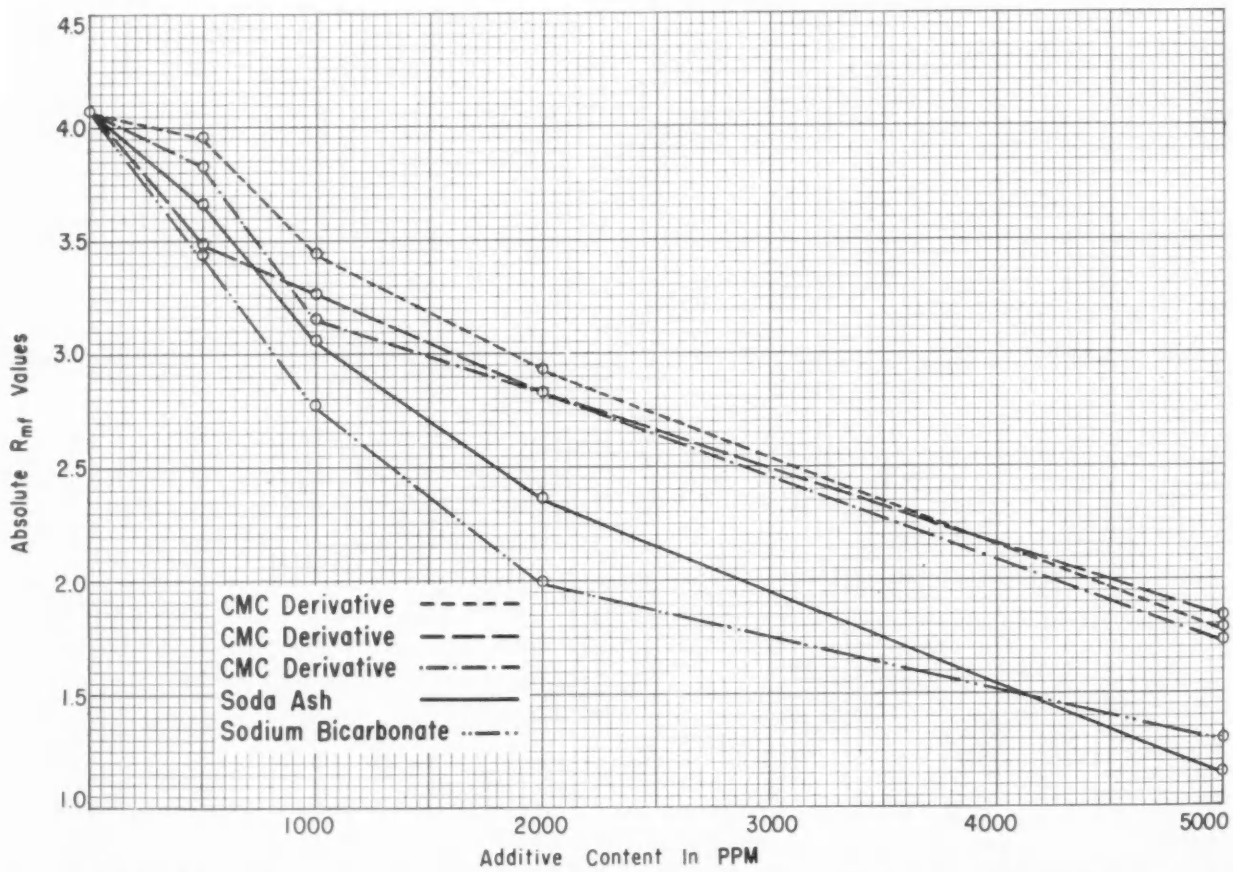


FIGURE 9—R_{mf} of different fluid-loss control agents and decontaminants vary with increasing concentration of additives. Measurements recorded at 75° F.

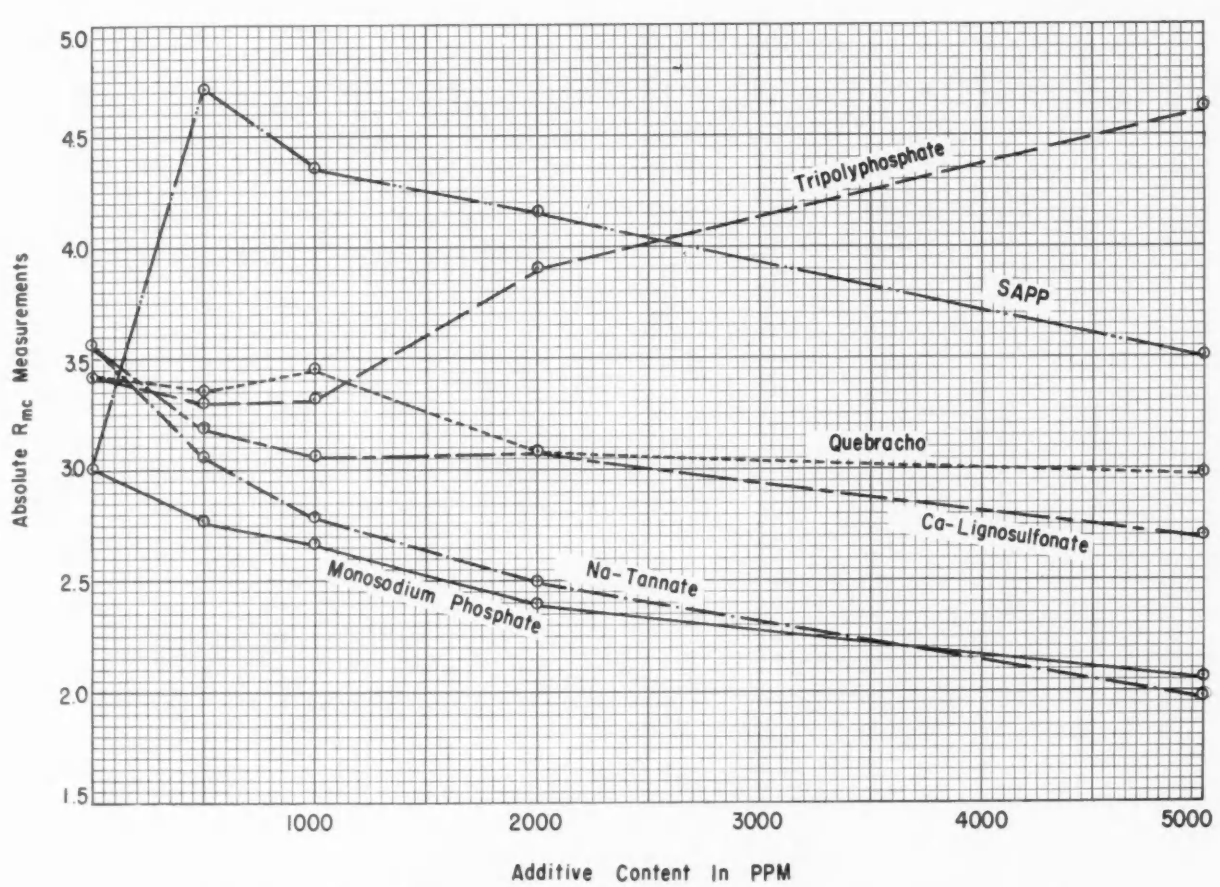


FIGURE 10—Thinner-R_{mc} relationship with increasing concentration of additives.

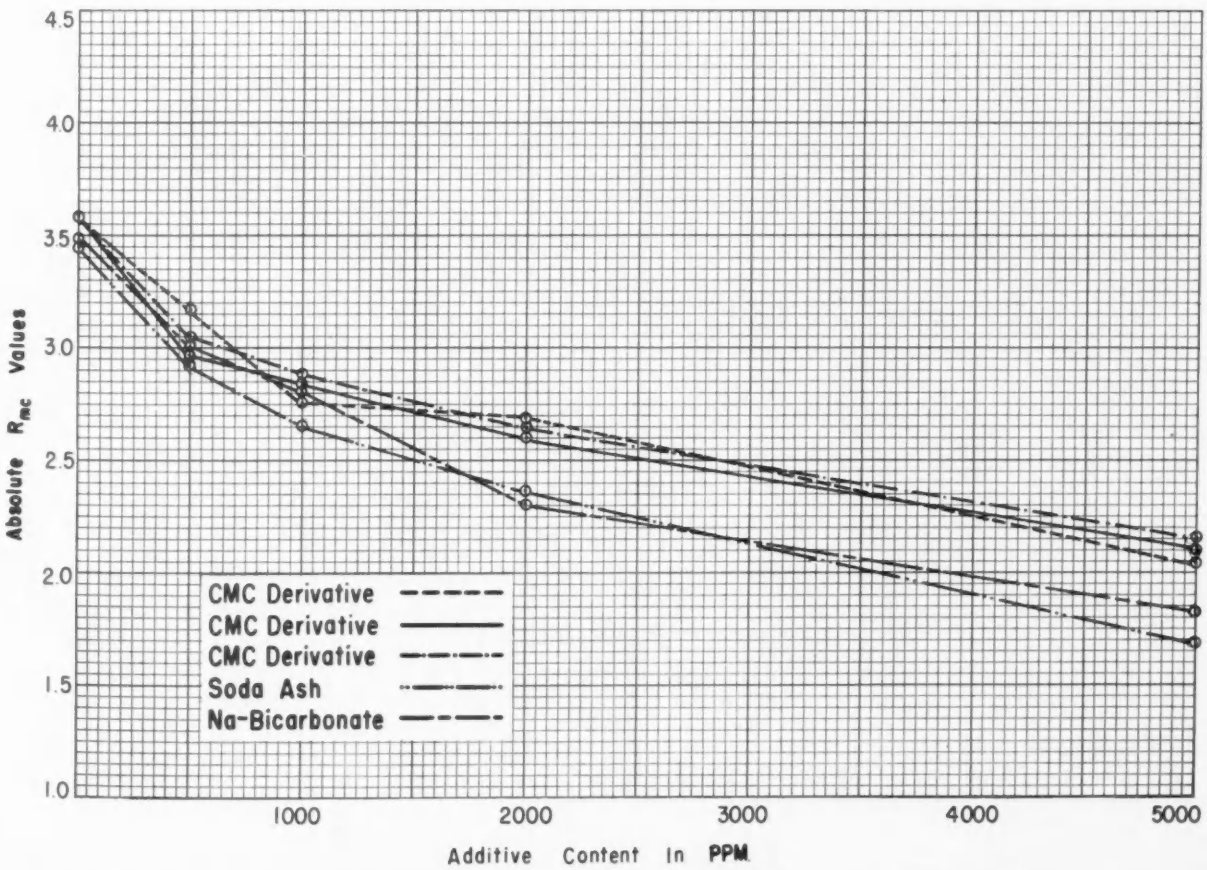
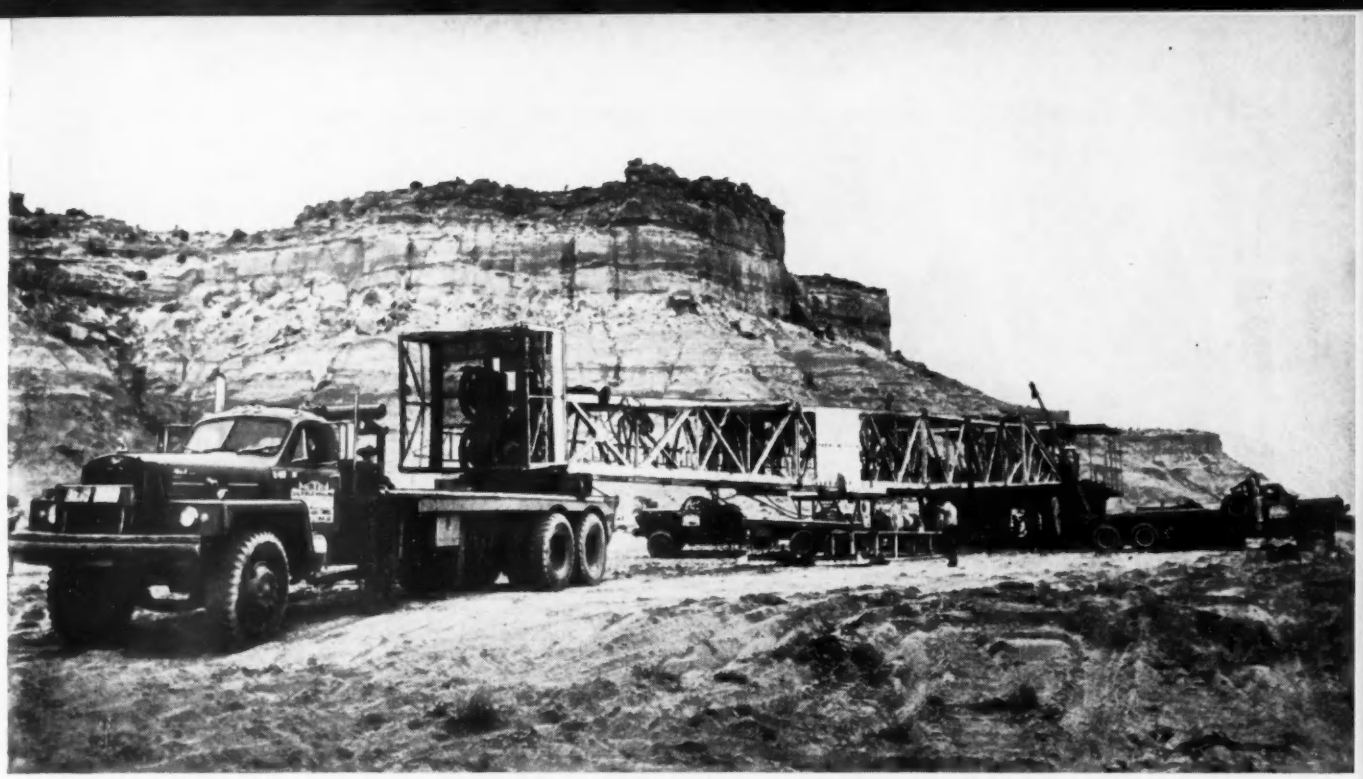


FIGURE 11—R_{mc} of different fluid-loss control agents and decontaminants vary with increasing concentration of additives. Measurements are recorded at 75° F.

MACKS MAKE THEIR OWN ROADS. Fewer delays mean more profits.



MOVING DAY WITH MACKS—With three extra-heavy-duty Macks on the job, an entire drilling rig is transferred from one site to another in a matter of hours instead of days. Ability of Macks to handle big loads fast means more profitable operation.

"We make more money with Macks!"

Earning dependable profits in oil-field hauling depends in good part on using the most dependable trucks. Alton H. Lee, Inc., oil-field transporter of Farmington, N. Mex., has experienced unequaled vehicle earning power since its first purchase of Macks in 1955 and now operates a predominantly Mack fleet.

"Our Thermodyne® diesel-equipped Macks operate up to 36 hours on only 90 gallons of fuel, hauling 100-barrel oil and water tanks over some of the roughest terrain in this part of the country. And in winter they cost us as little as $100 a month maintenance," says Mr. Alton H. Lee, company president. "I call that economy!"

"Our latest B Model Macks are following the pace set by our other Macks. They haul complete drilling rigs and draw works—often through the worst winter weather over roads that are often extremely poor—with very little time-consuming breakdown," says Mr. Lee.

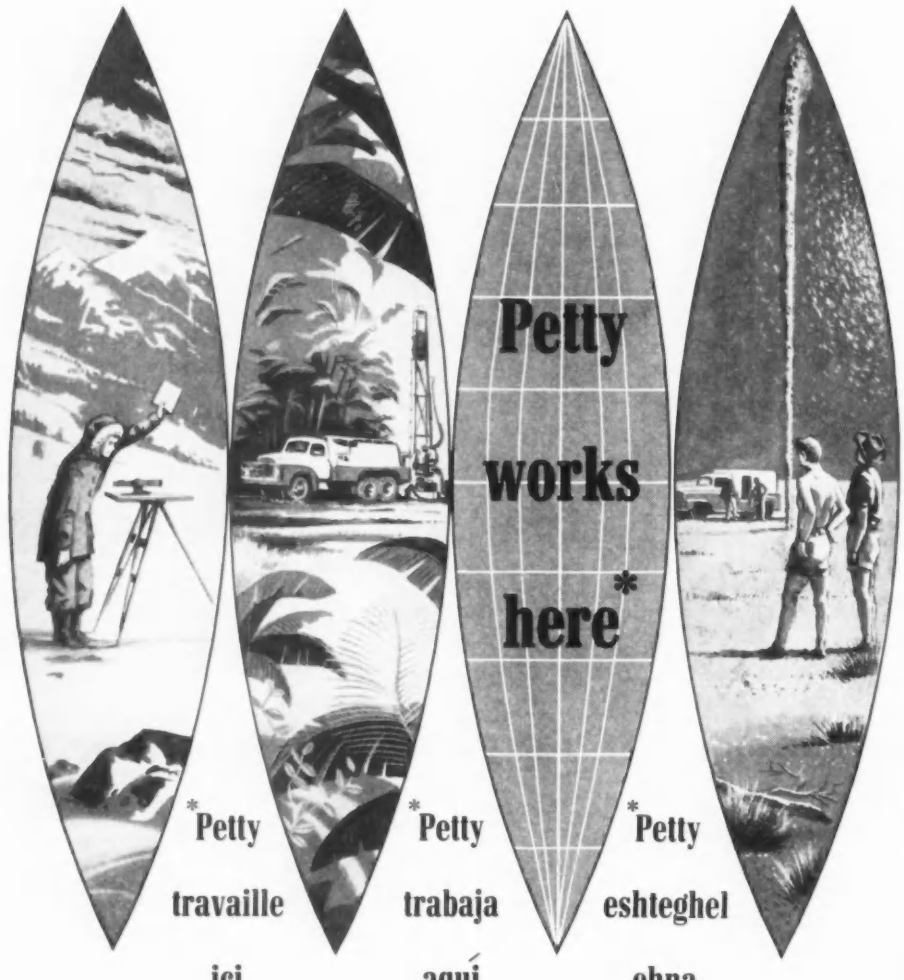
For trucks that can make more money for you, take a leaf from the books of operators like Alton H. Lee, Inc., whose performance records prove that Macks are consistently top earners. Your Mack branch or distributor will gladly supply facts and figures. Mack Trucks, Inc., Plainfield, New Jersey. Mack Trucks of Canada, Ltd., Toronto, Ontario.

8022

MACK
FIRST NAME FOR
TRUCKS

TRUCK-TESTING LOADS—Loading a draw works puts a tremendous strain on a truck chassis—here, over 100,000 lbs. on the rear axles alone—but Macks are built with the brawn to take this kind of punishment consistently without failure. Absence of mechanical breakdowns with Macks means more earning time on the job.

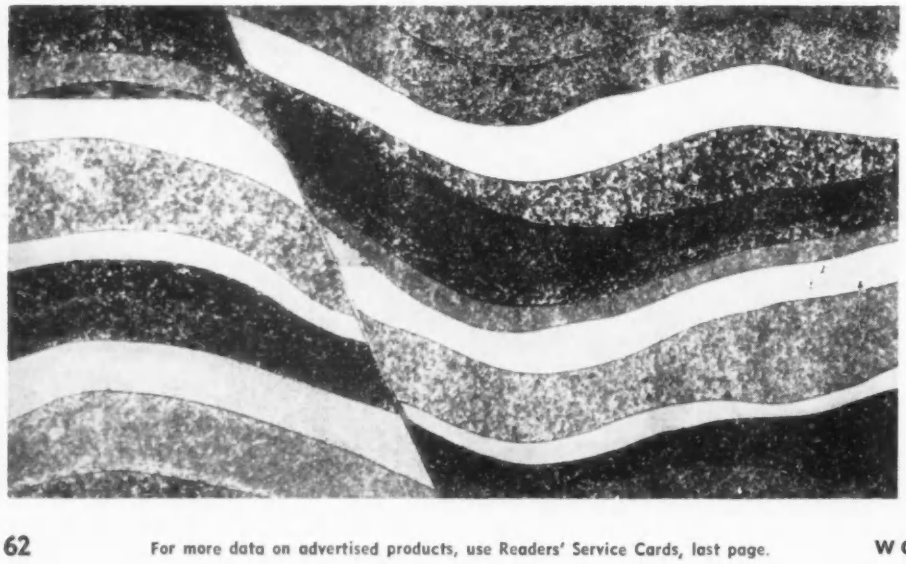
MACK
for over 8 straight years
NO.1
by far in sales of diesel trucks



Wherever geophysical research may be needed, the Petty patented* horizontal stacking technique will provide accurate subsurface surveys. Each subsurface point is verified by multiple ray paths, with only the reflection point common to all. Results: greatly reduced noise and maximum record clarity.

*U. S. Patent No. 2,732,906

Petty
GEOPHYSICAL ENGINEERING CO.
TRANSIT TOWER, SAN ANTONIO CApitol 6-1393



paper to the measuring cell. Therefore, Lynn[2] included experimentation on both R_{mf} and R_{mc} measurements. A cell was designed and built which could measure R_m, R_{mf} and R_{mc} in place at temperatures ranging up to 350° F. The R_{mc} value was measured on undisturbed mudcake under differential pressure.

Figure 4 shows R_m, R_{mf} and R_{mc} measurements on two laboratory prepared mud samples. Each sample of base mud was mixed in the ratio of 60 grams of commercial bentonite to one liter of water. A commercial powdered organic starch often used in controlling water-loss was added in the ratio of five grams to one liter of base mud; a different trade name starch was used in each of the two samples.

These were then converted to oil-emulsions by the addition of diesel oil in the volume ratio of 15 parts oil to 85 parts of the sample and mixed in a commercial blender. The curves of Figure 4 show that the effect of temperature on R_m, R_{mf} and R_{mc} differs somewhat from that on corresponding NaCl solutions. Also there is considerable difference in the change of R_{mf}/R_m and R_{mc}/R_m ratios with temperature for the two mud samples.

It was found that the R_{mc} values show greater departures from the NaCl chart than do values of R_m and R_{mf}. The departure for R_{mc} was often as great as 25 percent and could either exceed or be less than the NaCl value. Equally important in light of the method of measurement currently used by the service companies, it was found that the resistivity of an undisturbed mudcake might differ as much as 40 percent from that of a mudcake disturbed for measurement.

Figure 5 shows a comparison between mudcake resistivities measured disturbed and undisturbed, and emphasizes the differences found.

As has been noted, the work of Lynn was concerned with the change in R_m, R_{mf} and R_{mc} of various muds with an increasing temperature, but using a fixed quantity of each additive. Excellent work has been reported by Vögl[4] on the changes in R_m, R_{mf} and R_{mc} of laboratory prepared mud samples with changing concentrations of additives, but at a fixed (75° F) temperature. Figures 6 through 11 are graphs of measurements which were published in tabulated form in that paper. They have been plotted in

three basic groups of curves: the effect on mud resistivity of increasing concentration of additive (Figures 6 and 7), the effect on mud filtrate resistivity of increasing concentration of additive (Figures 8 and 9) and the effect on mudcake resistivity of increasing additive concentration (Figures 10 and 11). The additives studied are thinners (phosphates and tannins), fluid-loss control agents (carboxymethylcellulose derivatives) and decontaminants (soda and sodium bicarbonate).

These graphs show that the mud resistivity decreased with increasing concentration of all of the additives studied. This resistivity decrease is small with tripolyphosphate and quebracho, moderate with lignosulfonate and orthophosphate and large with all others. However, while the ratio R_{mf}/R_m decreased moderately with increasing concentration for most of the additives, there was a small increase shown for the carboxymethylcellulose derivatives. A medium to large decrease in mudcake resistivity with increasing concentration was shown for all additives except the phosphates. These showed increased resistivities, with that of tripolyphosphate still increasing at 5,000 ppm concentration which was the greatest used.

Lipson and Overton[5] have examined this problem of the use of complex muds from a slightly different angle. They pointed out that it might be better to use the electrochemical activities of the filtrates rather than the resistivities since alkalinity and calcium content play a more important part in the activity. Wyllie[6] first introduced this idea in his revision of the earlier SP equation to a ratio of electrochemical activities instead of resistivities. It would be fortunate if all filtrates could be treated as NaCl solutions.

Lipson and Overton attempted to determine the deviation of the electrochemical activities of these filtrates from the behavior of NaCl solutions. They found that drilling mud filtrates are definitely not electrochemically similar to NaCl solutions and that the activities of many of these filtrates vary widely from NaCl solutions, even though the electrical resistivity may be the same. They found that:

1. Phosphate muds have filtrates having greater activities than NaCl solutions of the same resistivity.

Continued on Page 66

Coming

ATTRACTIONS

Look for these feature issues of WORLD OIL during the coming months:

FORECAST-REVIEW ISSUE on February 15 will give predictions for the coming year and review happenings of the past year. Many oil men use this issue to plan their future operations. As a subscriber to WORLD OIL you receive the most authentic statistical data available.

EXPLORATION ISSUE on April 1 annually supplements the regular monthly coverage on exploration developments and techniques. This issue will bring you up to date on exploration progress.

API ISSUE in May will provide a comprehensive round-up of the best technical papers presented at various meetings of the American Petroleum Institute Division of Production.

LOOK FOR THESE and other coming issues of WORLD OIL—a publication *designed to help you do a better job on your job.*

If you work in the oil exploration-drilling-producing industry, or sell products or services to it, WORLD OIL can be of service to you.

* * *

WORLD OIL

Published by

GULF PUBLISHING COMPANY

World's Largest Specialized Publishers to the Oil Industries

P. O. BOX 2608 HOUSTON 1, TEXAS

SAVE YOURSELF

LOUISIANA
REPORT:

BAGS BEAT DRUMS

IN HANDLING
CAUSTIC SODA

Ask any roughneck. It isn't just that a bag of flake caustic soda is easier to carry from mudhouse to chemical barrel. It's that the sturdy Diamond bags practically eliminate injuries from back strain, burns from spilled caustic, and cuts and abrasions. Drums are bulky, hard to handle, and dangerous. See the next page for reasons why tool pushers and drilling engineers prefer Diamond bags over drums or any other type of bag. Specify Diamond bags from your dealer. Further information: Diamond Alkali Company, 300 Union Commerce Bldg., Cleveland 14, Ohio.

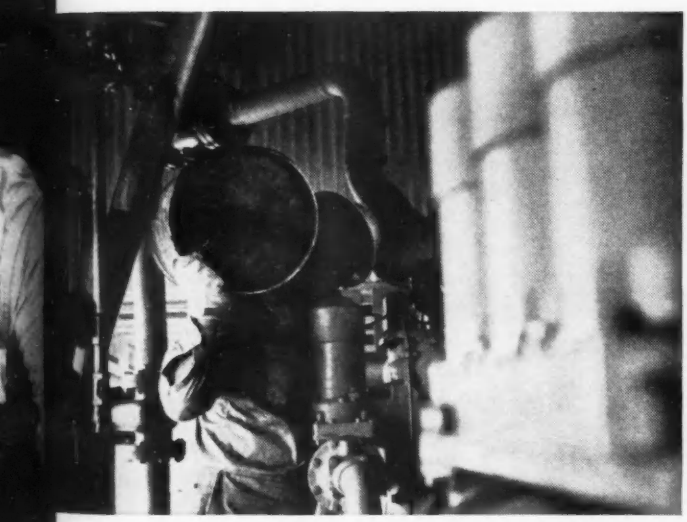
Diamond Chemicals

Barge rig photos at Barataria Bay, La.

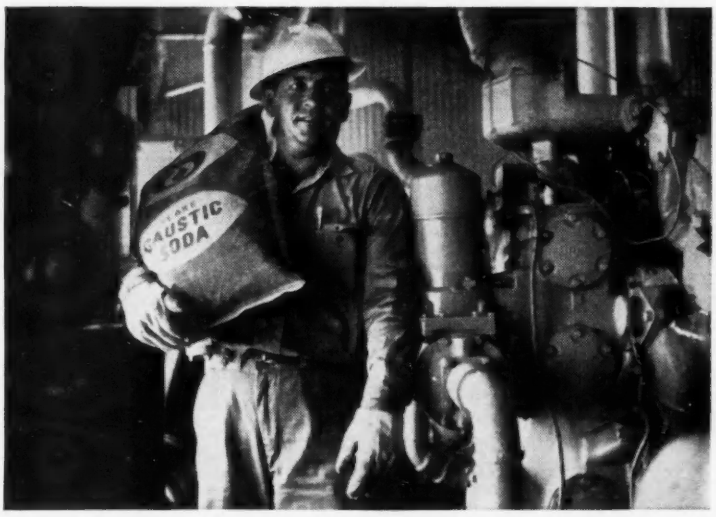
Bags are longer lasting. Roughneck totes the bag from mudhouse with ease. Diamond bags are stronger than drums—don't rust or corrode!

Drums are heavy, take more storage space, are more apt to slide and split. Loose lids can cause burns, sharp edges can cause injuries.

Diamond bags are easier to carry. Roughneck can lift bag and cover distance without getting pooped. No back strain means less time out.



Drums are harder to squeeze through narrow spaces. Watch out for popping lids, dented cans and sudden dropping. Dangerous, that's what!

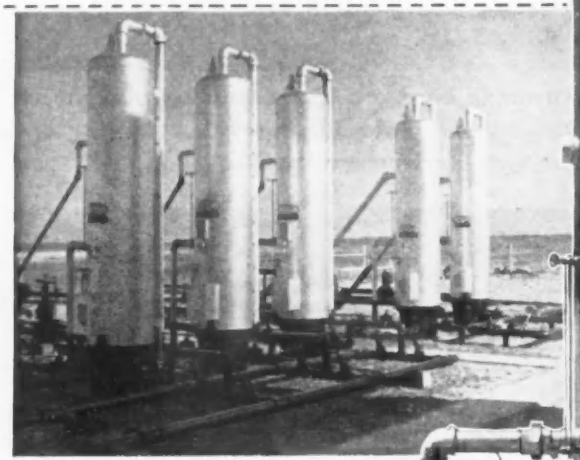


Bags go by obstructions easily—hardly wider than a man's back. Handy to carry in any position—can be put down anywhere. Won't split if dropped.

Pouring caustic into barrels is tricky with a drum. This is where hidden leaks cause lumps—lumps cause splashing—splashes burn!

Triple tough and safe: a burlap-and-asphalt sewn outer bag—a 10-mil heat-sealed polyethylene inner bag—make the bags strong, exclude moisture.

METROL®
Metering Separators
Do Double Duty
1 SEPARATE WELL FLUIDS
2 METER THEM



Battery of Model 24MS-0109C Type C Metering Separators

Model 24MS—0109C Type C Metering Separator

METROL® Metering Seperators save you money. Simple and rugged design assures continuous trouble free operation. They are easy to maintain at peak performance because of well designed, well made controls.

METROL Metering Seperators will seperate the oil and gas and will meter the oil. Patented* Snap Acting Liquid Level Control and positive valving sequence assures metering accuracy as high as 99.99%

Use of METROL Metering Seperators is accepted by most regulatory bodies. They are ideally suited for metering oil for royalty and tax payments, for testing wells, producing multiple completed wells into common storage tanks, test seperators at tank batteries and Automatic Lease Operation.

Sizes available are 16, 20, 24, 30, 36, 48, 60, and 72 inch diameter with 6′ to 20′ shell lengths in 125, 300, 600, 1200, 1500, 1800, 2000, 2400, and 3000 psi W.P. The units will handle from zero to 20,000 BPD. Dump volumes range from ¼ bbl. to 30 bbls.

*U. S. Patent No. 2,818,738

® Trade Mark Registered U. S. Patent Office

Every Unit is completely assembled, pressure tested, calibrated, and performance tested prior to shipment.

Competent Sales and Service Representatives located in all major oil areas.

OIL METERING and Processing EQUIPMENT CORP.
MELROSE 5-1226 • 4843 YALE STREET
HOUSTON 18, TEXAS

2. The filtrate from red muds can be treated as NaCl solutions.

3. The filtrates from calcium-treated muds show marked differences from a NaCl solution and the activity change is largely caused by the presence of caustic.

4. The sodium-surfactant shale-inhibiting muds produce a filtrate having about the same activity as a NaCl solution but the calcium-surfactant shale-inhibiting muds show a large deviation in activity from the response of a NaCl solution.

Conclusions. It is evident why there can be no definite fixed relationships between R_m and either R_{mf} or R_{mc}. Every mud is different in both additives used and in the concentrations present, and the only answer is to measure these resistivity characteristics individually for each mud at the time of logging.

A knowledge of R_{mf} may not be sufficient for exact quantitative analysis from the SP curve of electric logs recorded in these complex muds; consequently, it may be necessary to use electrochemical activities for substitution in SP equation and these will have to be measured individually for each well for filtrate resistivity values.

Accuracy of results obtained when using measured resistivities or electrochemical activities of the filtrate in the quantitative analysis of electric logs would be greatly improved if these values were measured at temperatures approximating downhole conditions rather than at surface temperatures. This would eliminate use of the present NaCl resistivity-temperature conversion chart, which has been proved to be non-applicable in many cases.

LITERATURE CITED

[1] Johnson, Hamilton M.: "A Re-evaluation of the Accuracy of Determinations of R_m, R_{mf} and R_{mc}"; Second Annual Venezuelan Meeting, Society of Petroleum Engineers of AIME, Caracas, November 6-9, 1957.

[2] Lynn, Ralph D.: "Effect of Temperature on Drilling Mud Resistivities"; T.P. No. 1302-G, Annual Fall Meeting, Society of Petroleum Engineers of AIME, Dallas, October 4-7, 1959.

[3] Lamont, Norman: "Relationships Between the Mud Resistivity, Mud Filtrate Resistivity, and the Mudcake Resistivity of Oil-Emulsion Mud System"; *Jour. Petr. Tech.*, August, 1957, pp. 51-52.

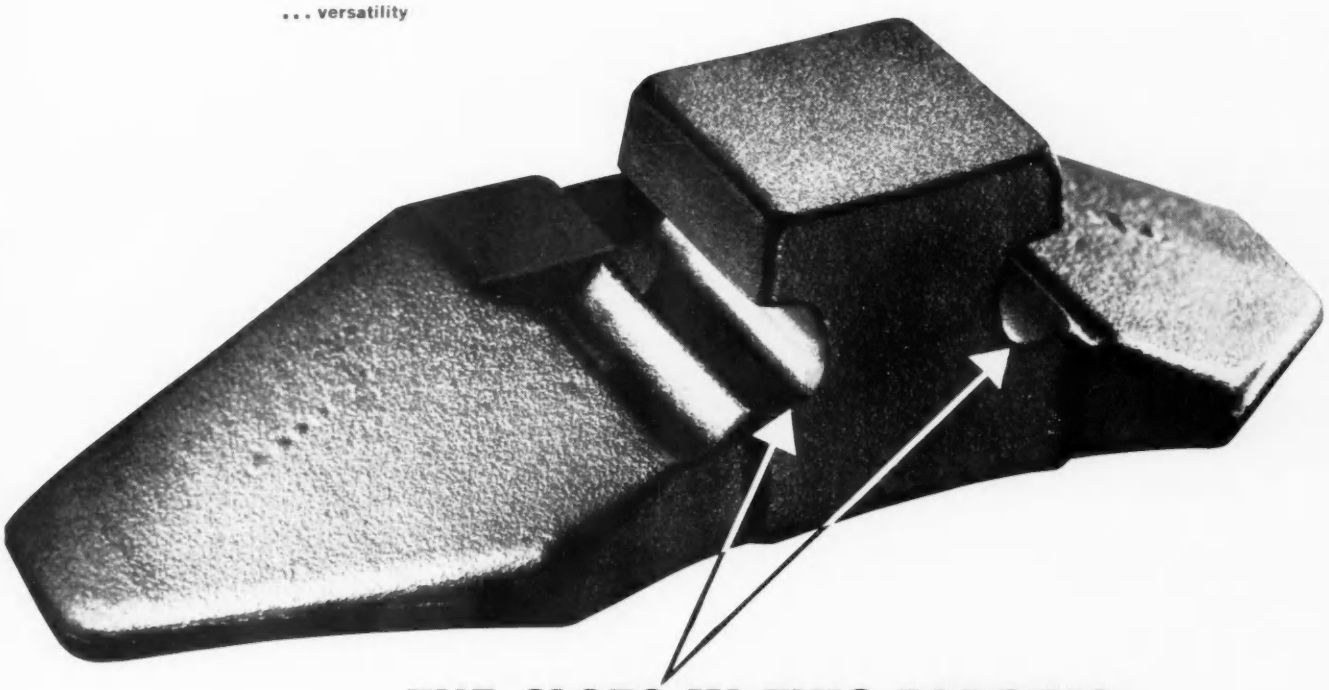
[4] Vögl, E.: "Effect of Various Drilling Mud Additives on the Electrical Resistance R_m, R_{mf} and R_{mc}"; *Erd. Zeit.*, Vol. 73, July, 1957, pp. 180-184.

[5] Lipson, L. B. and Harold L. Overton: "The Effect of Treating Agents on the Electrochemical Activities of Drilling Mud Filtrates," T.P. 867-G, Annual Fall Meeting, Society of Petroleum Engineers of AIME, Dallas, October 6-9, 1957.

[6] Wyllie, M. R. J.: "A Quantitative Analysis of the Electrochemical Component of S.P. Curve"; AIME Tech. Pub. 2511 (1949), *Petr. Trans. AIME*, Vol. 186, p. 17 (1949).

Steel

For strength
... economy
... versatility



THE SLOTS IN THIS FORGING SAVED OUR CUSTOMER SEVERAL MINUTES MACHINING TIME

The slots in the part above used to be machined. That took time and tools. It was expensive—*needlessly*.

Now, at Bethlehem's suggestion, the forged part is trimmed along the parting line, then placed in a special fixture in the trimming press where the slots are hot-broached.

The hot-broaching involved a small additional tooling cost. But, now there's no more machining . . . No more wear and tear on machine tools . . . No more waste metal. Take our customer's word for it, his savings more than make up his slightly higher tooling costs.

Our sales engineers will be happy to take a fresh look at your forgings, to talk over your ideas and problems. Perhaps they can help you cut machining costs, too. We suggest that you get in touch with our nearest sales office.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.
Export Sales: Bethlehem Steel Export Corporation

BETHLEHEM STEEL

BETHLEHEM STEEL

87th Congress holds...

10 keys to the future of oil and gas industry

In exclusive WORLD OIL interviews, top legislative and industry leaders discuss major issues to be considered in the next four years

THE OIL AND GAS industry, unlike many other segments of American business, has no elaborate program of requests for new legislation from the 87th Congress, or for immediate policy changes from the new chief executive. Thus, the industry's attention centers on potential federal action concerning:

- 27½ percent depletion provision
- Imports
- Natural gas legislation
- Area pricing of natural gas
- Reorganization of regulatory agencies
- National Fuels Policy study
- Gasoline taxes and highway financing
- Leasing regulations
- Tax reform
- Minimum wage and labor

All of these issues are receiving "acutely alert" attention from those upon whom the industry depends for accurate evaluations. It is the consensus among these sources that:

1. President Kennedy and the congressional majorities and minorities will move to implement or modify proposed programs at the most deliberative, studious and thoughtful pace the nation has witnessed in many years; that on some of these fronts (and within the oil and gas industry) movement already has started.

2. Pre-inauguration appointments, the organization of Congress, the budget and other major messages from the White House will clearly etch without delay the design for government-industry relations during the early 1960s.

3. Without taking priority over the problems of foreign affairs, welfare programs and anti-recession moves, action is expected on several of the major oil and gas industry issues before the new session of Congress is very old.

Realizing the impact the 87th Congress will have on the oil and gas industry, WORLD OIL, with the aid of Washington correspondent Frank C. Adams, has prepared the following analysis of 10 of the most important oil and gas issues—their current status and expected action to be taken.

The report was obtained from personal interviews with the company officials, oil and gas association leaders, senators, congressmen, and administration personnel most closely associated with each issue.

Depletion provision . . . *time to prepare for a stiff battle ahead*

Groundwork for legislative action on the 27½ percent depletion provision was laid less than 24 hours after the 87th Congress convened.

New bills to cut or eliminate depletion are in the hopper.

However, there are solid indications the industry will have at least a breather in which to prepare their arguments, i.e., President Kennedy's assurance that he will not make definite recommendations until a further study of natural resources taxation is made—Speaker Sam Rayburn's view that depletion's status will not be immediately threatened—return of the industry's friends of longstanding to positions of power—and the relatively unchanged composition of the Ways and Means Committee, Joint Committee on Internal Revenue, and the Senate Finance Committee.

Despite these bellwethers of deliberate and time-consuming depletion studies, a major legislative hassle is shaping up. Sen. Mike Monroney's (D-Okla.) view that the 27½ percent depletion would have a safer status if the provision for overseas production was jettisoned has made a deep impression on Washington observers for the industry.

Sen. Paul Douglas (D-Ill.) is reported ready to launch another, if somewhat modified, attack on the percentage level. A Senate nose count indicates he might be able to muster more strength than reflected by the 63-to-36 vote by which his percentage reduction amendment was defeated in the Senate last year.

President Kennedy's new head of the Council of Economic Advisers, Walter W. Heller, is known to favor sharp reduction of the depletion provision for oil and other minerals.

Rep. Hale Boggs (D-La.), who consistently helped fend off attacks on percentage depletion, anticipates no "precipitate action" to change the provision's status quo. However, there is nothing about its future to warrant complacency.

No competent observer in Washington is making wagers that the depletion provision is "safe" through 1964. Anticipating aggressive anti-depletion efforts ahead, Gulf Oil Corporation recently started a new educational campaign slanted toward the depletion provision for overseas production.

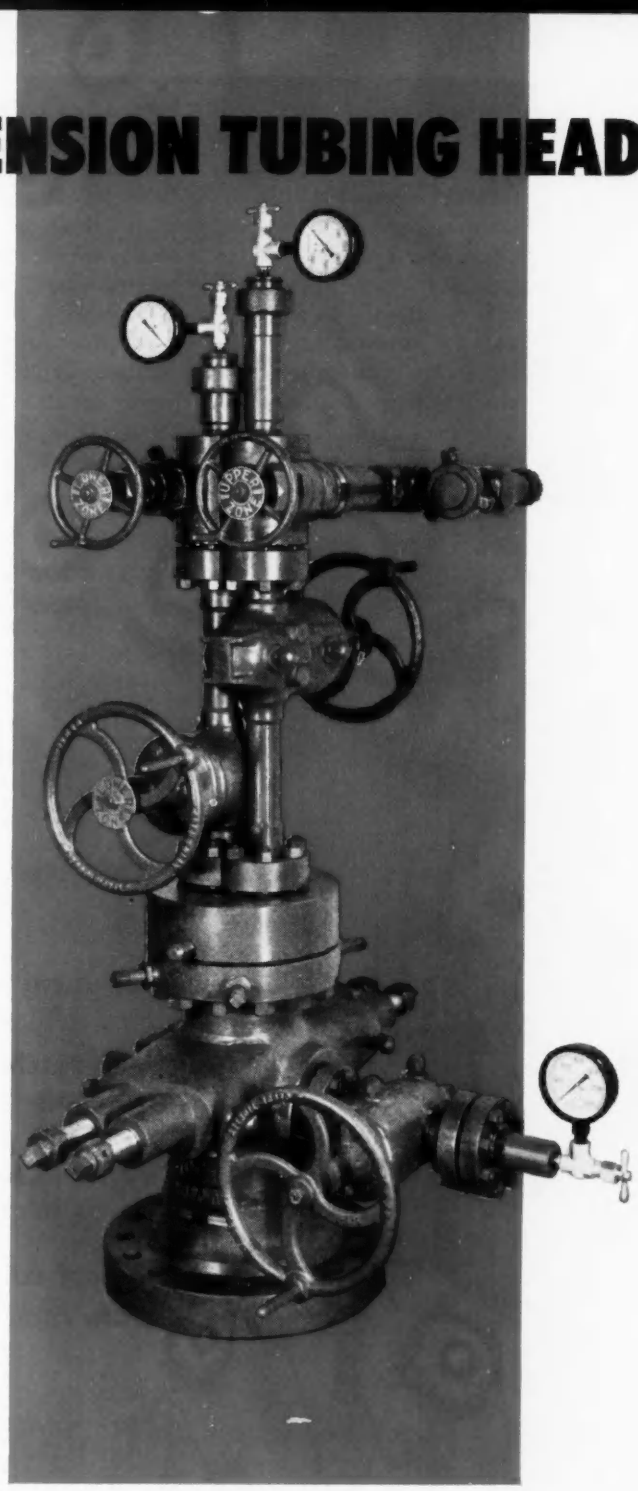
Oil import program . . . *alterations can be expected*

It will not surprise many observers in Washington if the entire issue of mandatory oil import control is not fought all over again in 1961—and the complex problems of policy and practice are not added to the many the Kennedy administration will be asked to deal with.

However, until there is time and opportunity for those who will take over top oil regulatory positions to educate themselves on the complexities of establishing new limitations

O·C·T DRT DUAL TENSION TUBING HEAD

Set and manipulate parallel strings in tension faster, safer



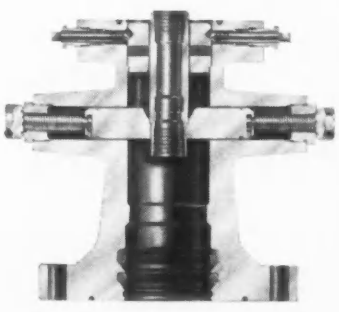
With this outstanding product of the Oil Center Tool Company, parallel strings of tubing can be set in controlled tension under blowout preventer control at all times. And flexibility, as in all O-C-T equipment, is an extra bonus. With the DRT, each string can be manipulated and set independently of the other.

Advantages of setting tubing in tension have been known for some time, particularly in the case of pumping wells where slack tubing strings result in high wear of rods and tubing. The advantages are even greater in the case of parallel tubing strings because of the much higher cost of workovers.

The O-C-T Dual Tension Tubing Head uses proved methods of sealing and supporting tubing. Action of both rams and sealing unit are direct and positive and both tubing strings may be run and set through blowout preventers with O-C-T Otis Back Pressure Valves installed. Annulus packoff is installed and activated before preventers are removed.

Available in full opening from 5½-inch to 7⅝-inch.

Contact the O-C-T representative nearest you for complete details about the DRT Dual Tension Tubing Head.



This cutaway drawing shows the independent supporting rams and seating element of the head. The packing around the tubing hangers is tightened by tightening hold-down screws.

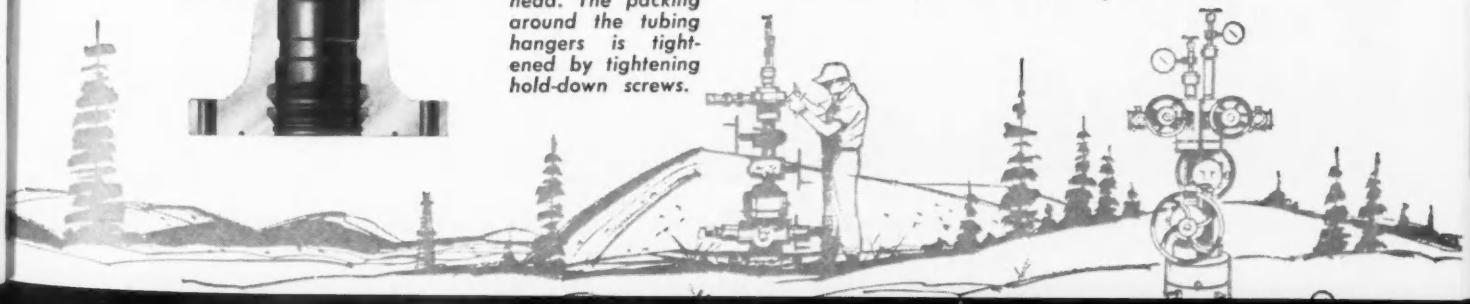
O·C·T

OIL CENTER TOOL CO.

SUBSIDIARY OF FOOD MACHINERY AND CHEMICAL CORPORATION

Address Export Inquiries for All Countries to
P. O. Box 3091, Houston, Texas.

where progress is a daily practice



and allocations, it is unlikely that early or drastic changes will be made.

It is evident from diverse positions taken by forceful groups within oil and coal industries, and by individual companies, that alterations in the current program will be demanded. While there is no clamor to abandon the program, some groups say it has gone too far in protecting domestic producers and the coal industry. Others take the position that the basic formula controlling import levels should be changed, and still others press for a basic change in allocation policy. The Interior Department also has been warned that elimination of basic provisions of the import control plan would result in challenges in the courts which might jeopardize the entire program.

The great disparity of views on import programming presented by the industry in late November, plus pressure from potent members of Congress, is seen in Washington as influencing the relatively slight changes reflected in the latest import levels issued by the Oil Imports Administration effective January 1.

President Kennedy has made no definite commitment on the oil import policy he will recommend as chief executive, but he has commented repeatedly on factors which are considered in formulating import levels. These include vitalizing the domestic economy, prices consumers must pay, and the protection of small business. He is fully aware of the viewpoints of his New England constituents who would like to see residual quotas increased, and he has been made well aware of the opposition of the coal industry to increased imports on residuals.

According to Donald C. O'Hara, general counsel for the National Petroleum Association, "At a recent hearing before the Interior Department almost every company, including those who had long been opponents of oil imports, endorsed the need for a limitation on quotas, although they disagreed violently on how import quotas should be divided within the United States.

"There is no strong demand from outside the industry for a change in the program, therefore, it is unlikely to be changed in any substantial way.

"The residual program is somewhat different. This is a highly explosive political issue because it involves not only differences of opinion within the oil industry, but also two vocal groups outside the industry—coal and New England consumer groups—who are diametrically opposed in their views on residual imports.

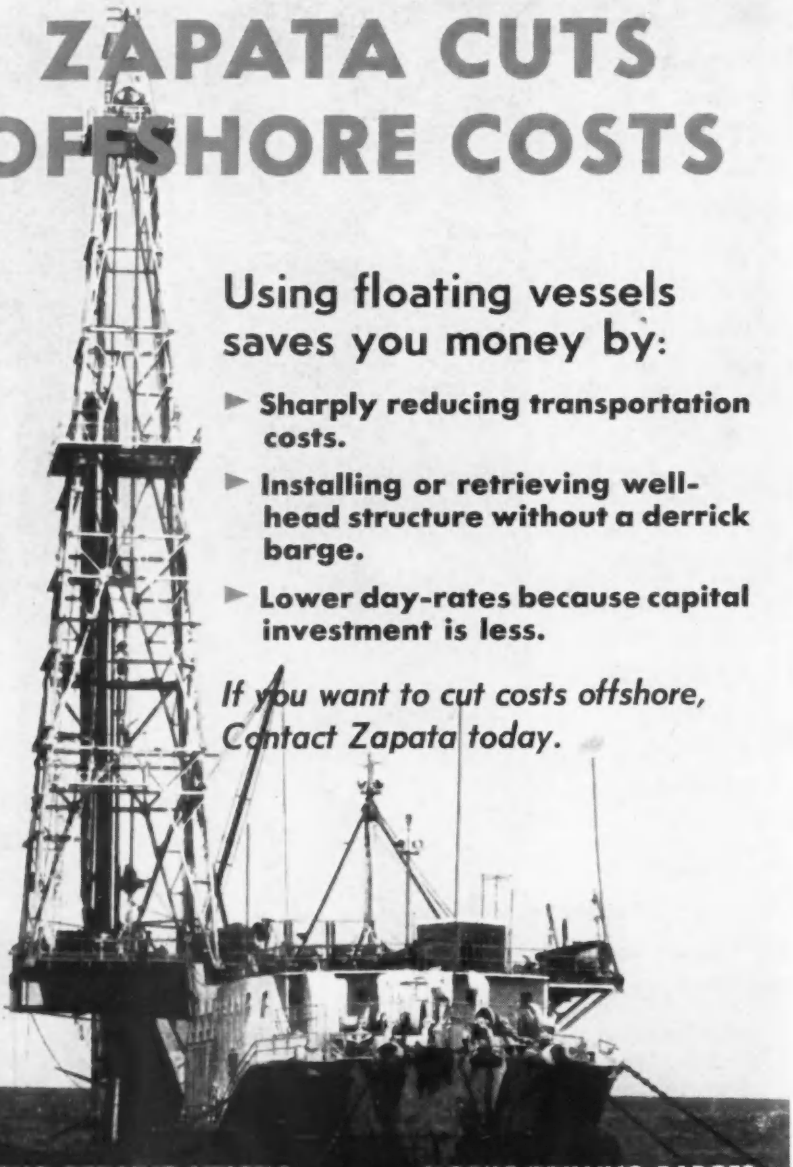
"There is a strong possibility that the form of this program may be changed (the Interior Department already has proposed a revision), but it is unlikely that there will be a change in the total quantity imported."

Natural gas bill . . . *little hope for action in 1961*

Leaders and spokesmen for the oil and gas industry continue to urge unrelenting efforts to induce Congress and the executive branch to initiate natural gas legislation.

Shortly after the 87th Congress convened, Rep. Orin T. Harris (D-Ark.) chairman of the House Commerce Committee, once again introduced a natural gas bill (HR-24) which was identical to HR-366 that he introduced two years ago. The new

ZAPATA CUTS OFFSHORE COSTS



Using floating vessels saves you money by:

- Sharply reducing transportation costs.
- Installing or retrieving well-head structure without a derrick barge.
- Lower day-rates because capital investment is less.

If you want to cut costs offshore, Contact Zapata today.

FLOATING DRILLING VESSELS (Operates in water 15-200 feet) • MOBILE DRILLING BARGES (Operates in water 20-110 feet)

ZAPATA OFF-SHORE CO.
HOUSTON, TEXAS

CABLE — ZAPATA HOUSTON
Phone CA 2-0395
1701 Houston Club Bldg.
HOUSTON, TEXAS

this Dowell tool has revolutionized well completion, stimulation and workover practices

Seldom in the history of the oil industry has there been a tool as versatile as the one used in Abrasijet*.

By directing high-velocity streams of abrasive in liquid against casing or hole wall, Abrasijet can perform many jobs not previously considered practical. First and most important, Abrasijet can be used to cut slots in casing and formation at low cost. By moving the tool during jetting, either vertical or horizontal slots may be cut to reduce breakdown pressures and to initiate fractures in the direction and plane desired. This use of Abrasijet has resulted in excellent gas/oil and water/oil ratios as well as outstanding production increases.

Second, Abrasijet has been successful in perforating wells that could not be perforated using explosives. Several thicknesses of pipe and cement can be penetrated simply by adjusting the jetting time.

Third, Abrasijet can be used in old wells completed in open hole to clean formation faces that have become plugged with various soluble and insoluble deposits. Since Abrasijet is mechanical in action, a detailed chemical analysis of the plugging deposit is not required.

Finally, there is a special money-saving application of Abrasijet. A tool with downward-pointing jets can use acid without sand to dissolve set cement in casing or tubing. In many cases this is safer and less costly than drilling out.

For detailed information on this versatile service—call Dowell. Dowell services and products are offered from more than 150 offices and stations in the United States, Canada, Venezuela, Argentina, Germany, France and the Sahara area. Dowell, Tulsa 1, Oklahoma. *DOWELL SERVICE MARK

SERVICES FOR THE OIL INDUSTRY **DOWELL**

DIVISION OF THE DOW CHEMICAL COMPANY

bill calls for a fair market price for producers' gas and contains some amendments supported by the coal industry. Also, Rep. John B. Williams (D-Miss.) introduced HR-172 to free producers completely from federal control of natural gas prices.

Despite these efforts, a WORLD OIL survey of those close to the natural gas issue in Washington indicates that prospects for enactment of a new gas bill during the 87th Congress are from dim to hopeless.

"A bill similar to those presented to Congress in the past wouldn't have the chance of a snowball in hell," says a realistic and high placed Ways and Means Committee member from a gas producing state—and he would like nothing more than to see such legislation passed.

"While there seems little or no chance to interest a majority of Congress in the type of bill passed in 1956, the natural resources and fuels policy studies the President has advocated may open the door for a new and productive approach to needed gas legislation," a knowledgeable spokesman for the American Petroleum Institute in Washington points out.

On the other hand, the new Congress will be urged to tighten still further controls over gas prices and the independent gas producers. One indication of this is a bill recently considered by the influential National Association of Railroad and Utility Commissioners. It would stiffen controls over both producers and pipe lines, and require the FPC to expedite its decisions. While such bills may not get far in Congress, the viewpoints they present do not improve the climate for new laws favorable to the natural gas industry.

Perhaps in recognition of the new administration's expressed concern with consumer welfare, there is a revitalized industry movement to take a new tack in gas legislation strategy. It would include an "educated" gas consuming public along with all elements of the industry in a drive to alert the nation and its lawmakers to the pressing need for incentives to encourage natural gas exploration and production.

Instead of being under wraps as in some cases in the past, the campaign would be open—a covenant for conservation with consumer interest in the forefront.

FPC's area gas policy . . . *can it survive the court tests ahead?*

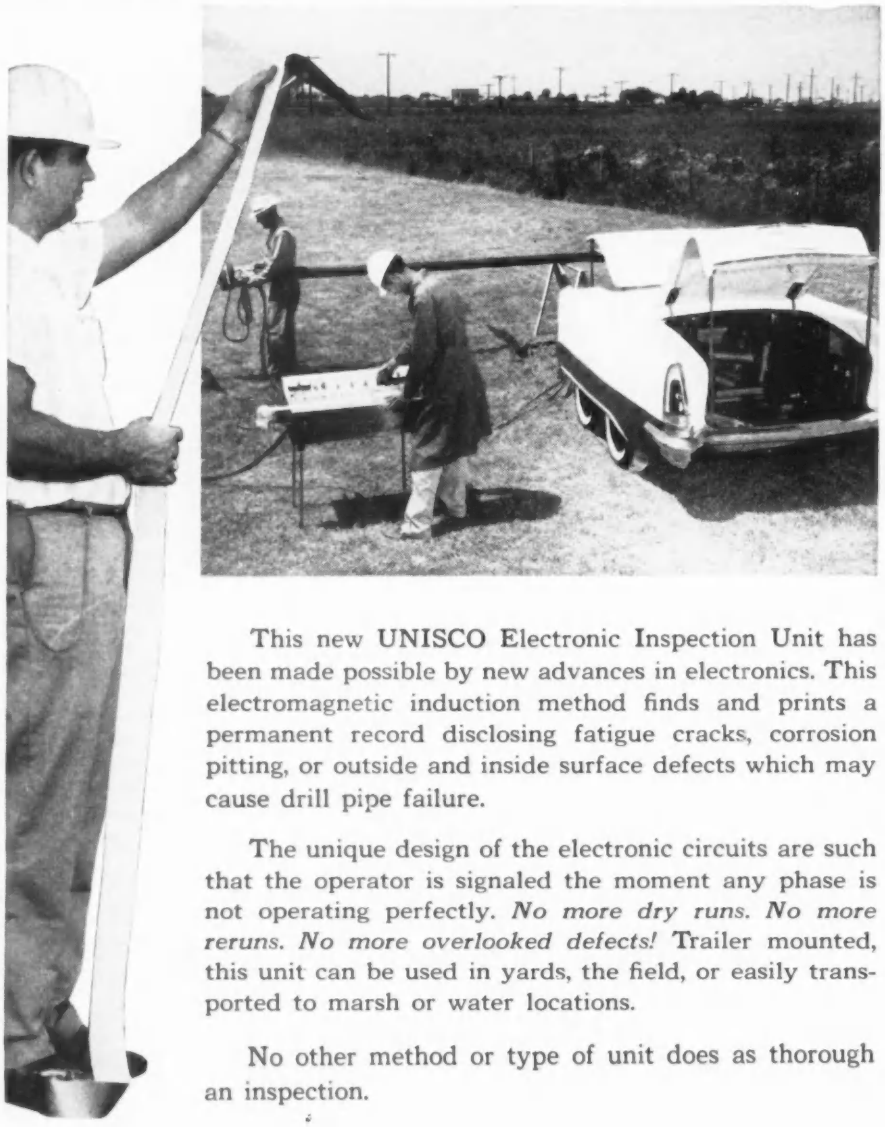
Another arena of uncertainty, conflict and confusion is the FPC's new area pricing system for independent gas producers.

When FPC Chairman, Jerome K. Kuykendall said the agency's new policy on area pricing would "open the door to a new era in the natural gas industry," he was right. Before the month was out, 13 companies entered the door to file requests for FPC action to:

- Initiate proceedings leading to a review of the geographical areas prescribed
- Promptly adjust upward the guide levels applicable to increases under existing contracts
- Abolish the dual price levels for old and new gas contracts as soon as possible.

It is anticipated by both the commission and the industry that FPC's decision in the Phillips case, or other similar cases, will be reviewed by the Court of Appeals and eventually by the Supreme Court. The Congress, it is repeatedly pointed out, could elimi-

CALL "UNISCO" FOR THE BEST IN DRILL PIPE INSPECTION



This new UNISCO Electronic Inspection Unit has been made possible by new advances in electronics. This electromagnetic induction method finds and prints a permanent record disclosing fatigue cracks, corrosion pitting, or outside and inside surface defects which may cause drill pipe failure.

The unique design of the electronic circuits are such that the operator is signaled the moment any phase is not operating perfectly. *No more dry runs. No more reruns. No more overlooked defects!* Trailer mounted, this unit can be used in yards, the field, or easily transported to marsh or water locations.

No other method or type of unit does as thorough an inspection.

UNISCO

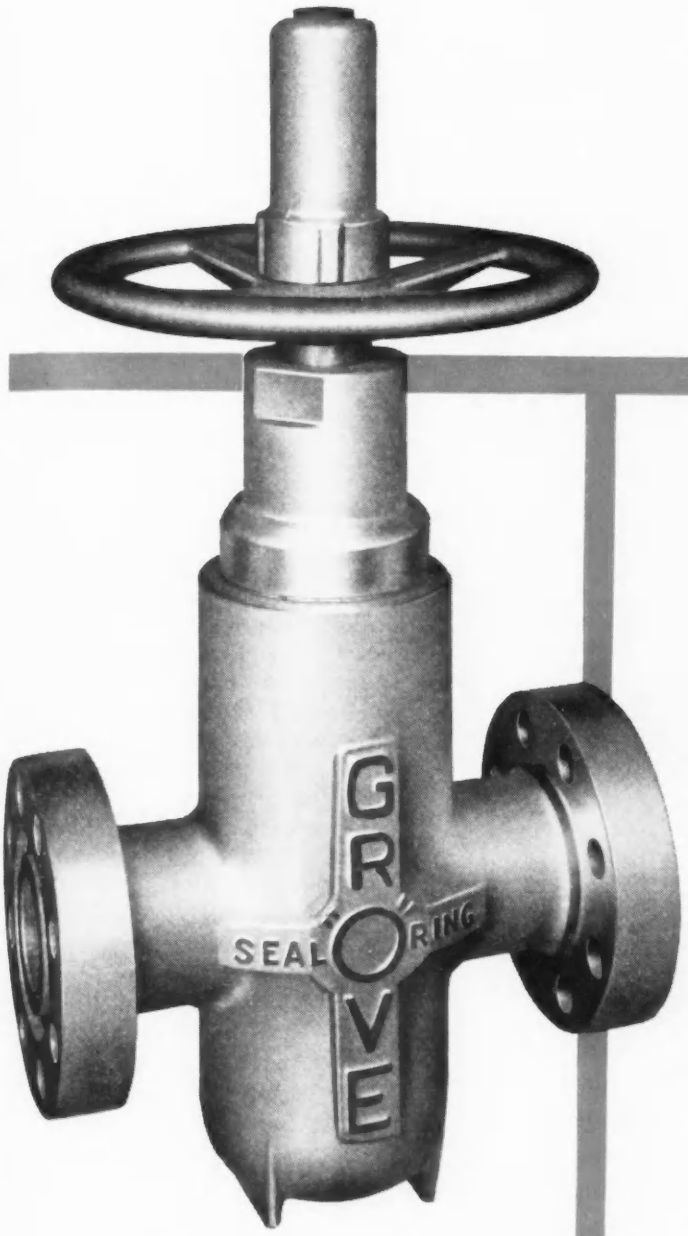
UNIVERSAL INSPECTION & SERVICE CO.

A DIVISION OF ATLAS BRADFORD COMPANY

Houston PA 9-9250, New Iberia EM 4-8666, Odessa EM 6-8241

These Grove G-2 Seal-"O"-Ring® Valves
RIGHT OFF THE SHELF

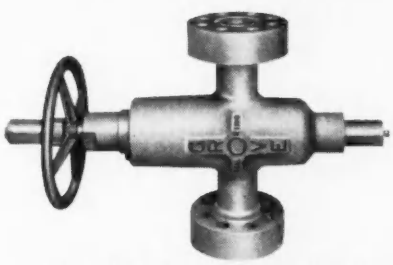
These Grove series G-2 production valves are available right now in most sizes — more coming. They feature Grove Seal-"O"-Ring design and the Grove Valve **big plus** — no lubrication ever!



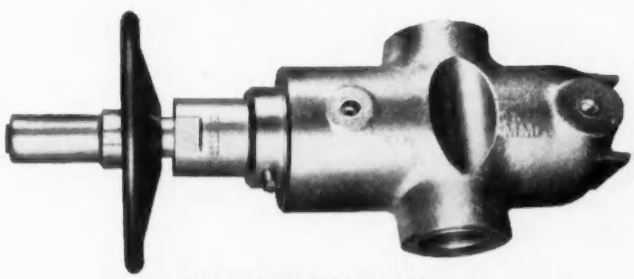
STANDARD GROVE G-2
Right-now shipment of standard series G-2 valves. Available in either flanged or screwed end. Sizes: 1½" through 4". Working pressure: 1000, 2000, 3000 and 5000 pounds.

Write for Bulletin #581

GROVE DUAL BLOCK
Available in 2" — 5000 #W.O.G.



GROVE BALANCED STEM
Available in 2" x 1⅝", 2" x 1-13/16", 3" x 2-1/16", and 3½" x 2-9/16" — 10,000 #W.O.G.



GROVE RECESSED BODY
Available in 1½" and 2" — 2000, 3000 and 5000 #W.O.G.

GROVE PRODUCTION VALVES

GROVE VALVE and REGULATOR COMPANY
A Subsidiary of Walworth
Oakland 8, Calif. • Houston • Los Angeles • Odessa
Tulsa • Denver • Chicago • New York • Dallas
Pittsburgh • Farmington, N. M. • Lafayette, La.
Harvey, La. • Longview, Texas • Oklahoma City • Pampa, Texas • In Western Canada: Grove Valve Ltd., Edmonton

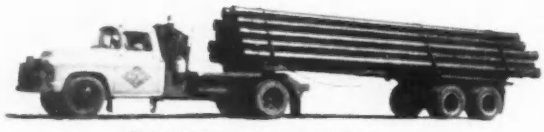
6321

Congrats and $25 for this quip to J. P. Denny, Phillips Petroleum Company, Box 1351, Odessa, Texas

Oil and gas men are quick to say that Lone Star products are "tough, top quality and delivered fast". Quick supply, and superior steel are among the reasons more and more have switched to Lone Star API casing, tubing and line pipe.

Exacting quality control combined with years-ahead manufacturing techniques today . . . are your guarantee of API standards in Lone Star pipe. And remember, delivery in the field is a matter of hours.

Neighbor, wherever you are, specify Lone Star and we both get a good deal.



© 1956 Lone Star Steel Company

Lone Star STEEL COMPANY

EXECUTIVE—SALES OFFICES
W. Mockingbird Lane at Roper • P. O. Box 12226 • Dallas, Texas
DISTRICT SALES OFFICES
912 Republic National Bank Building, Dallas, Texas
Houston, Texas | Midland, Texas | Tulsa, Oklahoma

nate much of the trouble and confusion, but action there is deemed remote.

President Kennedy is in a position to change the complexion of the FPC majority by mid-year, but what the industry must live with now is the present decision in the Phillips case and the new policy and price system announced along with it.

The general industry view in Washington is that the new area price policy may create more problems than it solves, i.e., what will happen to the new price structure if the courts decide against area pricing? The outlook is not a happy one.

Regulatory agencies . . . *greater federal control of business?*

In his recent scathing report on federal regulatory agencies, President Kennedy's new special assistant James M. Landis had this to say about the FPC:

"The FPC without question represents the outstanding example in the federal government of the breakdown of the administrative process. The complexity of its problems is no answer to its more than patent failures.

". . . These defects stem from attitudes, plainly evident on the record, of the unwillingness of the Commission to assume its responsibilities under the Natural Gas Act and its attitude, substantially contemptuous, of refusing in substance to obey the mandates of the Supreme Court of the United States and other federal courts."

Citing the tremendous backlog of cases to be handled by FPC and other regulatory agencies as one of the major reasons, Landis calls for the following changes in agency structure:

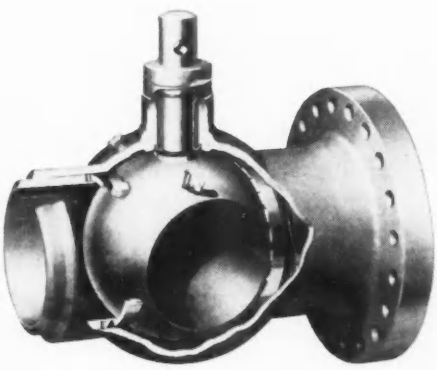
1. Legislation giving the President power to propose plans for reorganizing the agencies.

2. Set up three departments in the executive office of the president to develop and administer policies covering energy, communications and transportation—plus a fourth department that would encompass all the regulatory agencies. In short, tighten federal control of business and industry.

Although stiff opposition is expected in both the House and Senate, Landis' sweeping proposals are expected to create a new look in government relations with industry—even if sought for legislation is not passed.

8" x 6" x 6" 600 lb. ASA Flanged x Butt Weld Ball Valves on Pipeline meter run

CAMERON BALL VALVES



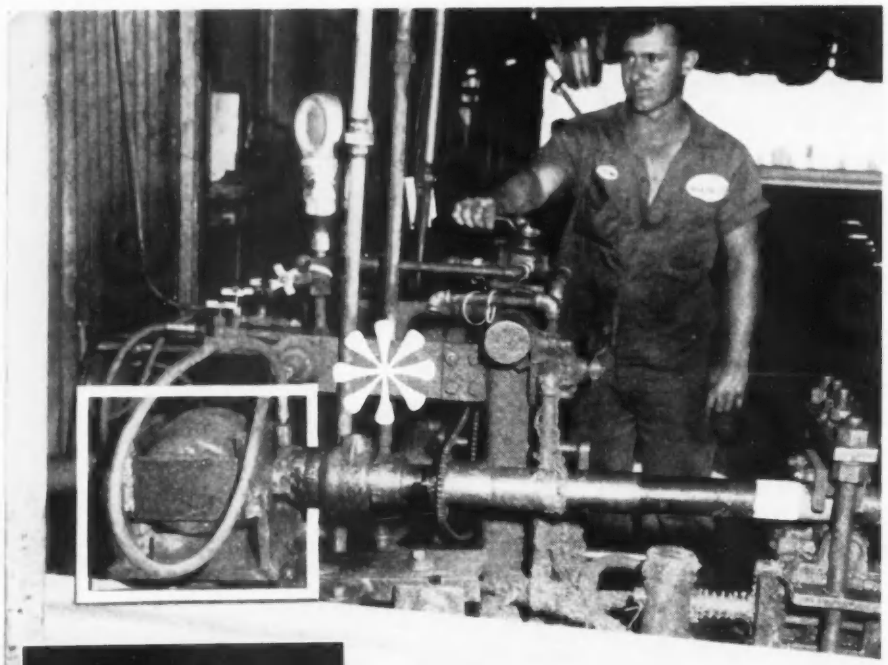
NEW — FOR GENERAL USE — for Pipe Lines — Chemical Refining and Gas Processing Plants — Oil Well Drilling and Producing

These valves, with the exclusive rotating seats, handle the most abrasive and corrosive fluids — cannot freeze — cannot develop excessive body pressure; they provide up-stream seating, double block and bleed, all with unbelievably easy operation.

They can be supplied in any material, size 2" to 36" and larger to required working pressures and with any type or style of operator desired. Cameron Ball Valves can be delivered from factories located in the United States, Canada, Mexico, England and France.

Cameron

CAMERON IRON WORKS, INC. • P. O. BOX 1212 • HOUSTON, TEXAS



HAMER

. . . only valve to stay in service, operating 800 times per day at 10,000 psi.

Hamer "D" Series
Plug Valve

Hardy-Griffin Engineering Corporation's program of testing 800 joints of oil field tubing a day at pressures of 10,000 pounds had been a valve killer with failure often occurring two or three times a day.

A HAMER "D" SERIES 2" MODEL DR150W PLUG VALVE was placed in service in January, 1959, and OPERATED FOR THREE MONTHS WITHOUT MAINTENANCE. The segments were then reversed and used another three months, then replaced. The HAMER Valve always seals bubble tight.

For reliable valve service talk to your Hamer Valve specialist.

✱ Chiksan Swivel Joint allows quick coupling of pipe to pressure unit . . . holds pressure without leaking.

WECO
WELL EQUIPMENT MFG. CORP.
HOUSTON, TEXAS
Division of CHIKSAN COMPANY *a subsidiary of* FOOD MACHINERY AND CHEMICAL CORPORATION
HV-4-60
fmc

WECO UNIONS

CHIKSAN SWIVEL JOINTS

HAMER LINE BLIND VALVES

HAMER PLUG VALVES

National Fuels Policy study

. . . more than a dozen resolution in the hopper

President Kennedy completely supports a National Fuels Policy study. He has tied it to the depressed coal mining area rehabilitation program, and has related it to both a natural resources and conservation survey, plus cost-of-living studies at executive and administrative levels. He has said repeatedly he will make the proposed study a first order of business after he takes office.

With this encouragement, coal-state congressmen already have introduced more than a dozen resolutions calling for the National Fuels Policy study. Action can be expected soon, with constant pressure from coal interests.

Coal's campaign for the study, lead by the National Coal Policy Conference, has been intense and effective. It has been held up by petroleum leaders as a prime example of what united and concerted organization can do. Despite substantial support in both houses of Congress, members from oil and gas producing states tabled the legislation in the House Rules Committee last year.

However, spokesmen for the oil and natural gas industries appear to have shifted their aim for the 87th Congress, and will concentrate not on attempting to kill the proposed study, but on circumscribing it; to see that whatever investigative groups emerge from congressional or executive action will not be completely dominated by the coal industry's point of view.

Most oil and gas leaders regard the proposed study as a dynamite-laden sleeper which had the ultimate aim of further centralization of government control over the nation's energy sources and fuels supply.

Donald C. O'Hara, general counsel for the National Petroleum Association, sums up the industry's views this way:

"The oil industry, of course, has no objection to a factual study and will be glad to cooperate in it as it has in many such studies in the past. We can only hope it will be conducted as an impartial study and not as an effort to bring the influence of government into the consumer's choice of fuels."

It is the belief in many quarters that concentrated resistance must be made to what is described as the coal

industry's effort to regain fuel markets lost through competition; to shut down residual imports to a trickle; to substantially restrict the use of natural gas for industrial boilers; and to set up criteria by which strategic and other considerations would have priority over such factors as relative price and demand.

Gasoline tax . . . *this temporary levy could become "permanently" temporary*

Before midnight June 30, 1961, a deficit-shy democratic Congress and an anti-deficit administration are due to decide whether to extend, increase or end the one-cent-per-gallon temporary federal gasoline tax (See January WORLD OIL, Page 17).

The petroleum industry and the major highway user organizations, i.e., American Automobile Association, have been united in support of an adequate highway program. These interests appear equally united in opposing excessive, inequitable and unfair tax burdens for highway construction and maintenance.

On both counts they are joined by wide public support. Petitions signed by nearly 6 million mortorists at service stations last fall asks Congress to allow the extra one cent federal levy on motor fuel to expire on schedule. And many, including President Kennedy, say they are not satisfied with the rate of progress of the highway program. More than 9,000 miles of the 41,000-mile system is open to traffic, but not necessarily complete; more than 4,000 miles are under construction. Cost estimates for the system have expanded from $27.6 billion in 1956 to $40 billion. Completion is due in 1972.

President Kennedy says in an exclusive interview for *Highway Highlights*, official publication of the National Highway Users Conference, that the federal highway program would be financed on "a shared basis between taxes on the users and general revenues." At present the road program is supported entirely by motor fuel and automotive taxes.

President Kennedy added, "It may be that we would want to end the tax in 1961, but it might also be necessary to continue the tax in order to keep up a high level of highway construction."

Objective observers for the oil and gas industry point out that some of Kennedy's top advisers are supporting an accelerated highway program, even to the extent of increasing gasoline taxes. They also warn that federal gasoline taxes have been labeled as "temporary" since the first was enacted in 1932, and have been regularly increased since then.

Looking ahead, the committees concerned with taxation and public works are virtually unchanged from their composition in the 86th Congress, while a President, committed to a stepped up federal highway program, was inaugurated January 20.

The new administration is fully aware that highway construction stimulates the economy, helps ward off recession, and that gasoline tax levies have successfully countered federal deficits.

Thus, the outlook for extension of the present tax level on gasoline is that it will stay put in the tax structure, and may even be increased.

Continued on Page 80

The *New* PROVEN WAY to get the . . . BEST CEMENT JOB

SPIN-O-LIZER CEMENT SPINNERS

Manufactured for All Sizes of A. P. I. CASING

SPIN-O-LIZERS take the doubt out of your cementing. Cement Bond Logs and Temperature Surveys have proven on well after well that SPIN-O-LIZERS give a more thorough and uniform cement job.

Avoid damaging your formation by using SPIN-O-LIZERS to eliminate the possibility of having to put a squeeze job on your formation.

- ★ ELIMINATES CHANNELING
- ★ REDUCES CONTAMINATION
- ★ SPACES MULTIPLE CASING STRINGS
- ★ CENTERS CASING
- ★ ACTS AS STOP COLLAR
- ★ MADE OF TENZALOY

Contact your favorite supply store, Clark Oil Tools or their representatives for SPIN-O-LIZERS, Clark Scratchers, Centralizers, and Stop Collars.

CLARK OIL TOOLS

PH. 767-2440, WICHITA FALLS, TEXAS, P. O. BOX 238

REPRESENTATIVES
Roy Manning—Wichita Falls, Texas
Bill Whitaker—Throckmorton, Texas
Kenneth Clark—Alice, Texas
Owen Marsh—Tulsa, Okla.
Ben Bolding—Guymon, Okla.
B & R Service Co.—Farmington, N. M.
Dave Crancer—St. Louis, Mo.
John Raymond—Hutchinson, Kan.
Globe Oil Well Cementing Inc. Great Bend, Plainville, Hill City, and Kiowa, Kansas.

Oil and gas lease law . . . *no major changes in the foreseeable future*

The 86th Congress streamlined the Mineral Leasing Act of 1920 by expediting process, raising the per acre rental from $3.40 to $5 for a 10-year period, and establishing acreage limitations for lease and option.

The Bureau of Land Management (Interior Department), with public and industry comment on proposed regulations in hand, is completing final implementing rules for submission to the Secretary of the Interior and appropriate Congressional committees. Emergency aspects presented by the old encumbered Leasing Act had earlier been met by Congress and the Interior Department.

Besides the straight 50 cents per acre per year rental, the main feature of the new Act provides that, within the existing limitation of 246,081 acres to be held by any one person in any one state, a person may hold directly by lease or indirectly by option a maximum of 246,080 acres, except that there shall be holdings of options in excess of 200,000 acres.

Since to a very large extent the senators and congressmen who wrote the new Mineral Leasing Act remain in office, no major change in the measure is expected in the foreseeable future.

Tax reform . . . *strong support in Congress, but action will be painfully slow*

Early in 1961, some 175 specialists appeared before the Ways and Means Committee, offered 2,400 pages of prepared testimony and an equivalent number of pages of oral testimony stressing the need for a revision of the Internal Revenue Code and indicating areas in which tax reform is acutely needed.

The direction and pace of federal tax reform in Congress will await a cue from the budget, State of the Union, and other initial messages from the White House. The oil and gas industry, as represented in Washington with other business, professional, labor, and farm interests, await proposals the President will make to keep the budget balanced as he promised, and at the same time launch the Kennedy-advocated programs for increased welfare, public works, education, and defense, along with other mammoth commitments.

Ways and Means Committee Chairman Wilbur Mills (D-Ark.), along with an impressive number of other Congressional leaders, has long advocated reforms in the present tax structure, but at the same time they have taken the position that tax easement and reduction can be safely enacted when revenues materially increase or expenditures of government are held in check.

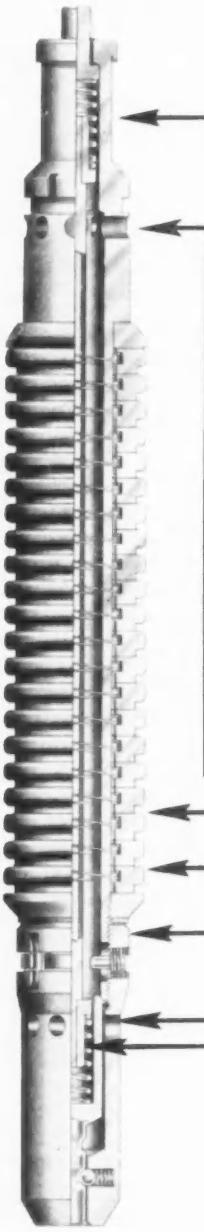
In a recent statement on the tax reform complex, Chairman Mills warned that the magnitude of tax reform and Code revision problems precludes Congress from coming up with an over-all tax package immediately.

Few in Washington expect immediate action in the area of tax revision and reform; but there is intense interest in the extent the incoming administration will be influenced by "left leaning" economists.

Minimum wage and labor . . . *favorable action on the way, despite opposition from conservatives*

In addition to a higher minimum wage and broader welfare programs,

Continued on Page 85



H B

PISTONS SEAL EFFECTIVELY, STOP PARAFFIN DEPOSITION IN TUBING

Harold Brown Company *piston lift* equipment has wide application in both oil and gas wells. Its benefits are so numerous that the low installation costs are frequently paid out in only a few months.

1⅜" standard fishing neck
Heat treated alloy steels throughout

Large by-pass outlet ports

Long life hard chrome heat treated steel wobble washers each loaded with a shifting spring

2" or 2½" washers interchangeable

By-pass valve body

By-pass inlet ports

By-pass valve stem and disc—all monel

The leader in the Piston Lift field, Harold Brown Company offers you the creative engineering and superior equipment to solve your production problems.

HAROLD BROWN COMPANY

P. O. Drawer 25047 • Houston 5, Texas
Phone: JAckson 6-4411

labor leaders want tangible White House recognition for organized labor across a wide spectrum of government organization here and abroad—and are so telling the President. They are asking for status and footing in federal affairs "equal" to business and industry.

These appeals, it is generally agreed in Washington, are encountering attentive and sympathetic ears in Congress and in the pre-inaugural camp of the Kennedy organization.

The President has repeatedly confirmed his commitment to push the minimum wage from $1 an hour to $1.25, and a solid front of labor and liberal Congressional support is taken for granted. It is in the area of minimum wage legislation that the strength of southern conservative-right wing Republican coalition is expected to be tested in the early days of the 87th Congress.

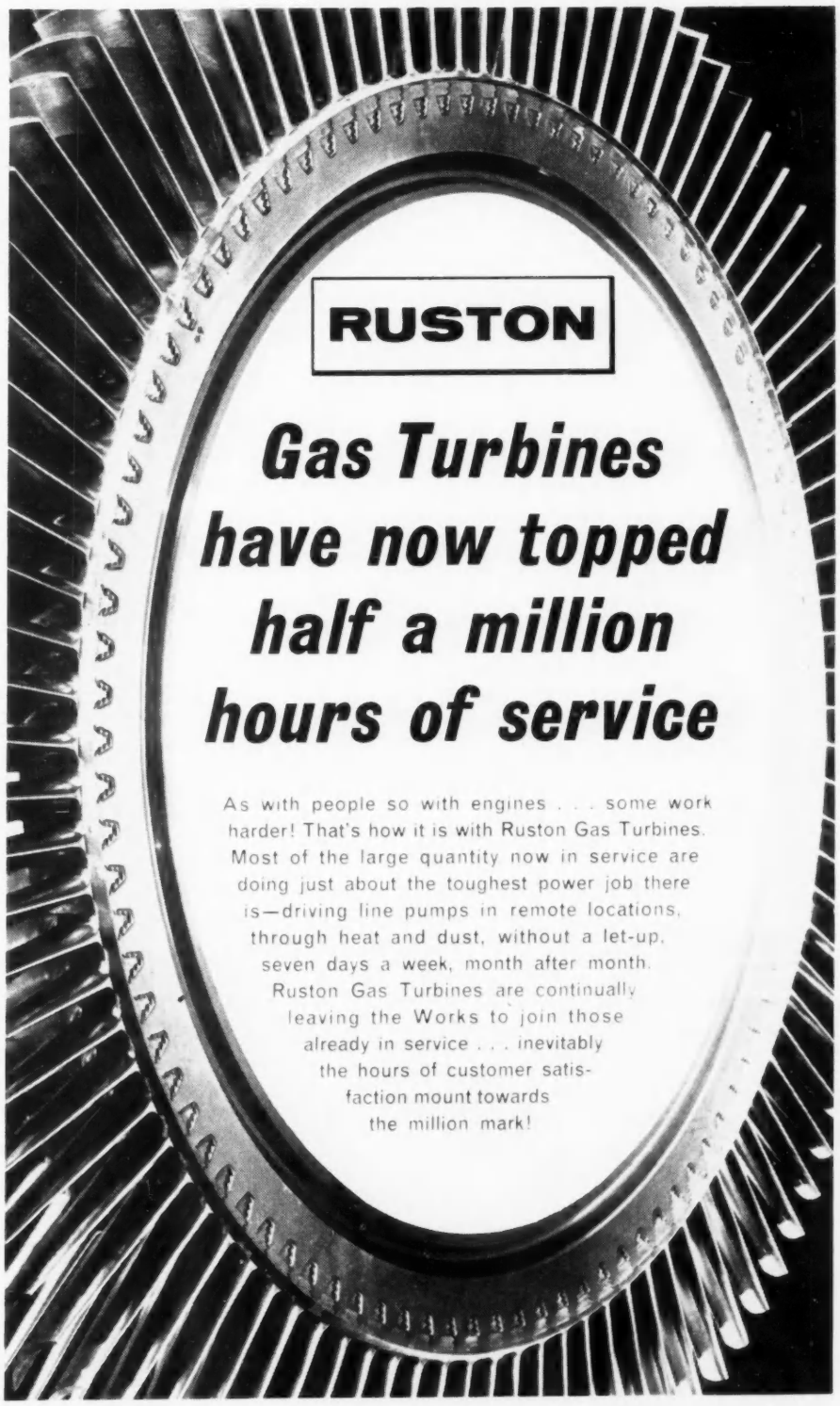
Majority party leadership on both sides of Congress are expected to guide a new bill to enactment early in 1961 with White House approval a certainty.

Despite the fact that President Kennedy made his Senate reputation largely in the field of labor and that the Democrats are committed to a pro-labor program, the drive of organized labor for favorable legislation, even with the administration's support, will not be cut and dried in this session of Congress.

Republican Congressional leaders, Sen. Everett Dirksen and Rep. Charles A. Halleck are both pledged to put a brake on what they consider "extreme" Democratic-backed legislation. To this end they have announced they will seek to work in coalition with such Democratic conservatives as Rep. Howard Smith (D-Va.), and other southern lawmakers who in the past have eagerly sought alliance with like-minded Republicans.

However, labor leaders and Congressional liberals have been encouraged by statements by Vice President Lyndon Johnson and House Speaker Sam Rayburn expressing confidence that an impressive portion of the Kennedy and Democratic platform will be enacted without undue delay.

Oil and gas industry observers contacted as 1960 drew to a close believe they are right. —**The End**

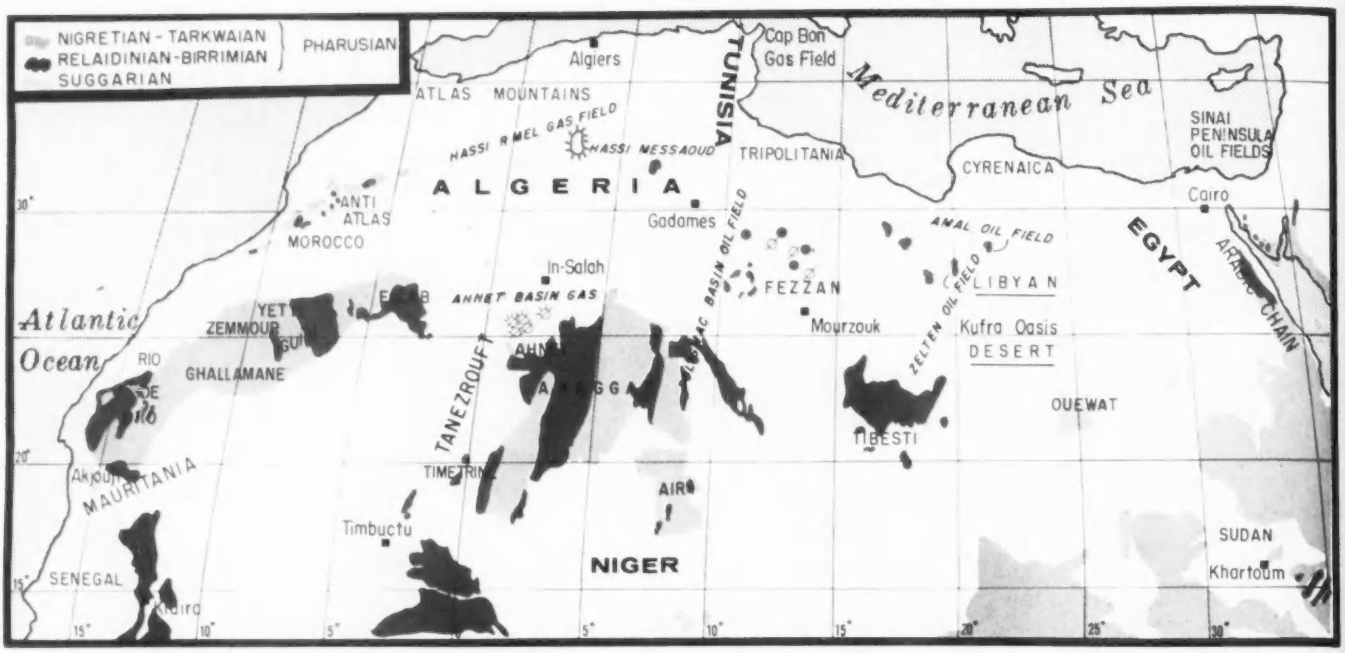

RUSTON
Gas Turbines have now topped half a million hours of service
As with people so with engines . . . some work harder! That's how it is with Ruston Gas Turbines. Most of the large quantity now in service are doing just about the toughest power job there is—driving line pumps in remote locations, through heat and dust, without a let-up, seven days a week, month after month. Ruston Gas Turbines are continually leaving the Works to join those already in service . . . inevitably the hours of customer satisfaction mount towards the million mark!

RUSTON GAS TURBINES

Powers up to 1260 b.h.p. *at 80 F. amb. temp.*

RUSTON & HORNSBY LTD · LINCOLN · ENGLAND

Associated with Davey, Paxman & Co. Ltd., Colchester



ERRATA—This map is intended to replace the one published on Page 75 of the January 1961 issue of WORLD OIL. The legend did not correspond to the color scheme used on the map. The error is corrected here. Large portions of the ancient Tibesti and Ahaggar massifs are composed of Relaidinian-Birrimian systems classified by Lelubre. The Birrimian series is mentioned as pre-Cambrian in I of Table 1 (Page 74, January 1961 WORLD OIL). The Suggarian evidently corresponds to the older of two series described by Medina in the Spanish Sahara. The Tarkwaian series is mentioned in Table 1 of the article as applying to the pre-Cambrian II series of the Gold and Ivory coasts.

Also on Page 72 of the January issue, Figure 2 (map accompanying article "Lower Paleozoic prospects enhanced in Sahara area") the contour values represent meters below sea level. The contour values were not fully explained. As stated, contours were on the base of the Paleozoic.

EZY-VUE
PRESSURE GAUGE

THE FIRST ACCURATE PRESSURE GAUGE For Applications Requiring... RUGGEDNESS and DEPENDABILITY

CAPACITIES: 3,000, 5,000, 6,000, 10,000, 15,000 PSI Metric Equivalents Available.

MARTIN DECKER

WRITE FOR DESCRIPTIVE LITERATURE
MARTIN-DECKER CORPORATION
3431 CHERRY AVENUE, LONG BEACH 7, CALIF.

World's principal manufacturer of Oil Well Drilling Instrumentation

From the ROYAL FAMILY of
KING SWIVELS
NEW
30, 40 & 50 KG SWIVELS
All with 3" watercourse

NEW

packing box arrangement eliminates necessity of removing gooseneck and bearing housing to change packing, thus eliminating thread-galling.

SUPERIOR PERFORMANCE

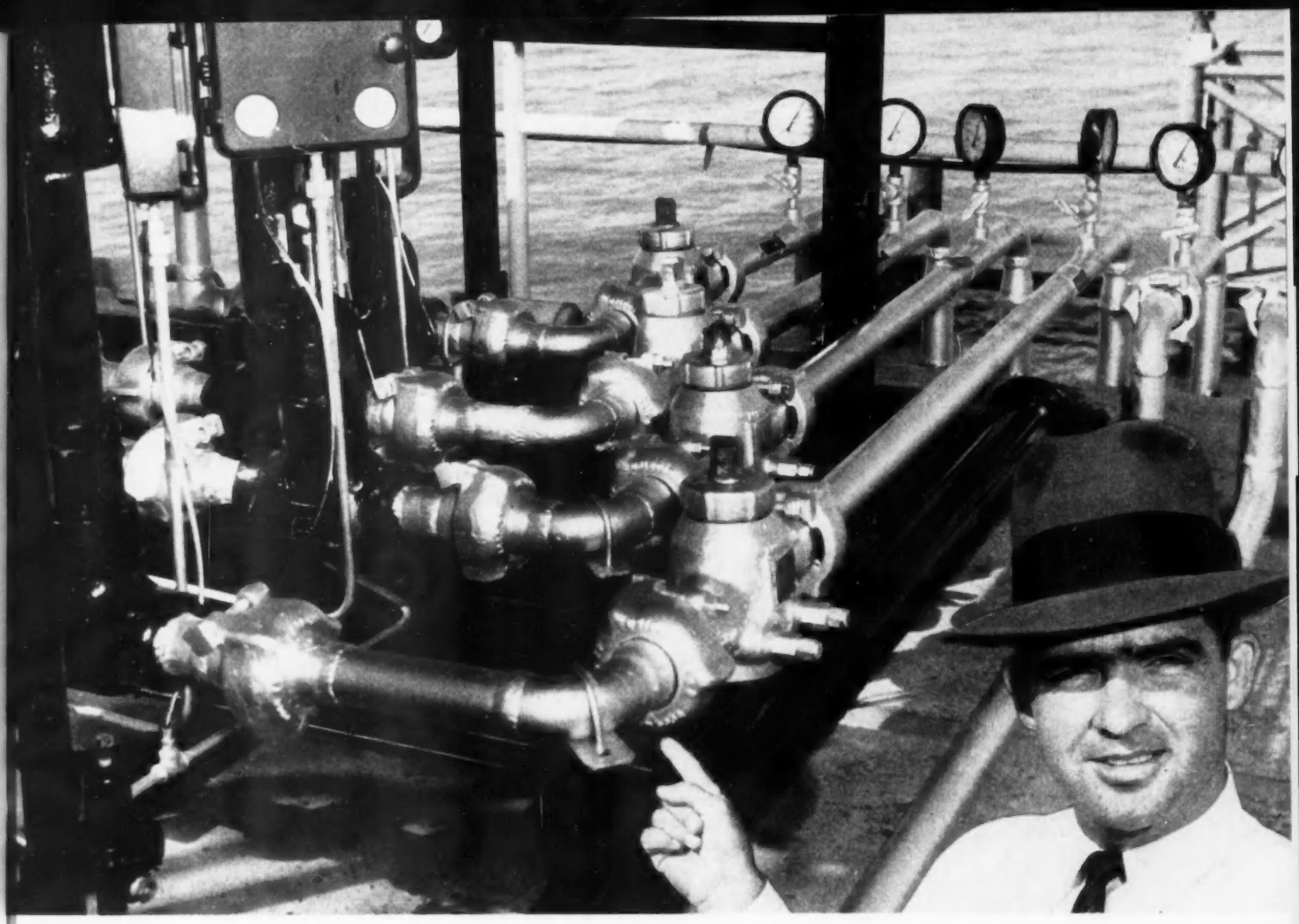
at 100 rpm to 6,200 feet with 2⅞", 3,800 feet with 4½" drill pipe. . . . Perfect for drilling relatively shallow oil wells, the deepest of water wells, workover rigs and slim hole drilling!

NEW!

- Wash-pipe packing box arrangement — interchangeable, all 3 sizes.
- Oversize water course (ideal for conventional and reverse circulation)
- Zerk Fitting in stuffing box for simplicity in lubrication of Chevron or V-Type packing.

KING OIL TOOLS
P. O. BOX 15146 • HOUSTON 20, TEXAS • ORchard 3-3421

Export: R. S. STOKVIS & SONS
17 Battery Place
New York 4, N. Y.



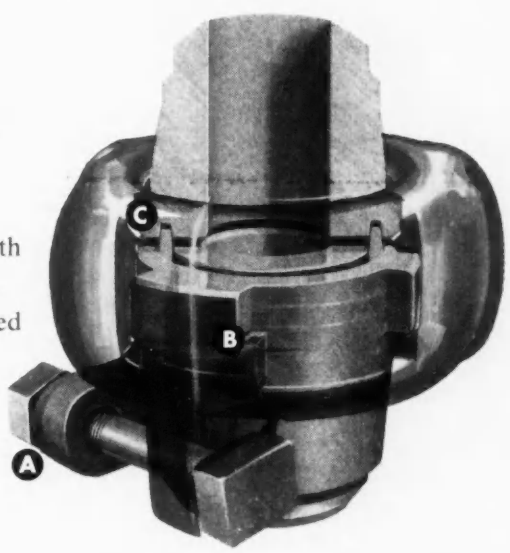
IT COSTS NO MORE TO GO FIRST CLASS . . .

UNIBOLT COUPLINGS are lighter and stronger than flanges, too!

There is no other coupling quite like the UNIBOLT. It is small, light, and compact, yet it is actually stronger than a big, heavy, flanged coupling. (For example, a 2-inch, 3000-lb. w.p. Unibolt Coupling is 28% stronger than a 2-inch, Series 900, flanged connection.) It is available in sizes from 1 inch to 42 inch, in malleable or steel, with loose metal seal ring or renewable resilient gasket, and with threaded hubs or hubs for butt welding. Its parts are interchangeable; it can be installed in close quarters; its vital seating area cannot be damaged accidentally.

So sound is its design that the Unibolt Coupling principle has been applied to all sorts of oil field drilling and production fittings: tees, crosses, positive chokes, adjustable wing valves, ball joints. Also, closures for pipe line scraper traps, blow-downs, product and water filters, and other large diameter pressure vessels.

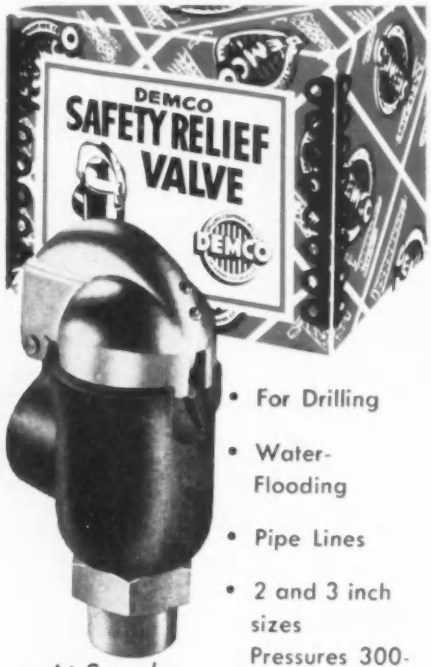
A complete catalog is yours for the asking.



Note in the illustration above how the tightening of a single tee-head bolt (A) causes identical tapered interlocking shelves in the nut member and on the lug hub (B) to travel against each other. This leverage action exerts tremendous pressure on the seats and seal ring(C).

THORNHILL UNIBOLT CRAVER CO.

P. O. Box 1184, Houston, Texas



- For Drilling
- Water-Flooding
- Pipe Lines
- 2 and 3 inch sizes Pressures 300-5,000 lbs.

At Supply Stores Everywhere

DRILLING EQUIPMENT MANUFACTURING CO.

DEMCO

845 S. E. 29th • Oklahoma City, Okla.

PERFORATE TUBING IN THE WELL

KINLEY TUBING PERFORATOR

J. C. Kinley Co. Licensees

ABILENE, TEXAS—Hudson-Eads, Inc....OR 2-5331
ANACO, ANZOATEGUI, VENEZUELA
Anzoategui Wire-Line Service, C. A.
BAY CITY, TEXAS—J. P. Graham.....CI 5-4526
CABIMAS, ZULIA, VENEZUELA
Wireline Engineers, S. A.
CASPER, WYOMING—C. A. White.....3-5264
CORPUS CHRISTI, TEXAS—Tolle, Inc...TE 5-5367
CORPUS CHRISTI, TEXAS
J. D. Ball Wire Line Service Co.... ....TU 3-7762
FARMINGTON, NEW MEXICO
B & R Service, Inc.....DA 5-2393
FORT MORGAN, COLORADO—C. A. White....919
GLENDIVE, MONTANA—C. A. White...EM 5-3833
HOBBS, NEW MEXICO
Horne Well Service Co.....3-5396
HOUMA, LOUISIANA
Assoc. Eng. & Equip., Inc.....UP 2-0347
HOUMA, LOUISIANA—Camco, Inc.....7330
HOUMA, LOUISIANA
Fred Haynie Oil & Gas Well Service...UP 3-7885
HOUSTON, TEXAS
Mid-Western Well Ser. Co.....RE 4-4262
HOUSTON, TEXAS
Long Line Production Control.....GR 3-5739
LAFAYETTE, LOUISIANA—Camco, Inc. CE 5-3124
LIBERAL, KANSAS—Rainbo Service...Main 4-3598
MIDLAND, TEXAS
Luccous Service & Eqpt. Co.....MU 2-8311
NEW IBERIA, LOUISIANA
Cardinal Wireline Specialists, Inc.....EM 4-5165
NEW IBERIA, LOUISIANA
Klein-Deco Wire Line Service.....EM 9-6632
ODESSA, TEXAS
Camco Wire Line Service, Inc.....FE 2-6497
ODESSA, TEXAS
John Kuykendall Wireline Service Co...FE 7-7210
OKLAHOMA CITY, OKLAHOMA
Rainbo Service Co.....ME 4-2131, ME 4-0105
PETTUS, TEXAS
Eddie Jones Eng. Co., Pettus 15, Beeville.FL 8-1218
SHREVEPORT, LOUISIANA—Camco, Inc....8-3615
VICTORIA, TEXAS—Camco, Inc.....HI 3-9521
WICHITA FALLS, TEXAS—Tudson-Eads, Inc.
322-8584, 322-1792, 767-8727, 723-4690, 767-3793

Men in the industry

W. H. Helmerich, III

W. H. Helmerich

Walter H. Helmerich, III, is the new president of **Helmerich & Payne, Inc.,** succeeding **W. H. Helmerich,** who continues as chairman of the board of directors. Helmerich, III, was former executive vice president. Also, **Daniel R. Toll** was elected a vice president.

Hobson Mann has been appointed staff engineer in the Drilling Department of **King-Stevenson Oil Company, Inc.**

Peter Jacobsen, Jr., has been named head of the interpretation section in the geophysical research division of **Jersey Production Research Corporation.**

W. O. Ham, Jr., Houston, and **H. F. Nabors,** New York City, have been elected vice presidents of **Continental Oil Company.** Ham is general manager of the Domestic Production Department and will continue to headquarter in Houston. Nabors is production manager for the Foreign Exploration and Production Department and will continue to make his headquarters in New York City.

E. M. Christensen has been promoted from landman to district landman at Lafayette, La., and **Warren E. Bart,** formerly geologist, has been named district geologist at Roswell, N. M., for the Exploration Department of **Tennessee Gas and Oil Company,** Canadian and domestic exploration and production division of **Tennessee Gas Transmission Company** of Houston. Other personnel transferred include: **Jack Morris,** district exploration superintendent, and **George E. Anderson, Jr.,** district geophysicist, both moved to Casper, Wyo., from Denver; **Raymond C. Blakely,** district geologist, to Shreveport, La., from Denver, and **E. L. Collins,** district geophysicist, to Wichita, Kan., from Wichita Falls, Texas.

W. A. Keleher, Albuquerque, N. M., attorney and historian, has been named to fill the unexpired term on the board of directors of **Pubco Petroleum Corporation** of the late **Ralph J. Wann.**

Turner L. Kunkel has been appointed Los Angeles Producing Division manager of **Texaco Inc.** Kunkel will be in charge of all Texaco production activities in California, Oregon, Washington and Alaska. Kunkel succeeds the retired **J. Harold Puls. Dosh T. McCreary** has been named to succeed Kunkel as chief geophysicist of Texaco's Exploration Division at Houston.

J. Byron Eckert has succeeded retired **Arthur G. Reed** as regional executive for North Africa, France and Spain for **Mobil International Oil Company.**

Arthur H. Bransky has been appointed assistant general patent attorney and **Fred R. Ahlers, Michael Dufinecz,** and **Samuel Kahn** have been appointed senior attorneys in the Patents and Licensing Department of the **Standard Oil Company (Indiana)** Research and Development Department.

A. H. McHarg, formerly senior staff analyst in the Organization Department, **The California Company,** has been appointed manager of the department. **J. Van Wilson, Jr.,** formerly Southwestern Louisiana Division landman, has been named to the position of manager-contracts and titles. McHarge replaces **Everett K. Hoffman** who has transferred to Denver, and Wilson replaces **Morris A. Betts** who also has moved to Denver.

John C. Johnston has been elected a vice president and director of **Pan American Petroleum Corporation** and also was named division manager of the company's Texas-Louisiana Gulf Coast Division in Houston. Johnston succeeds **L. Chase Ritts, Jr.,** who has been named coordinator—crude oil production, purchasing and transportation for **Standard Oil Company (Indiana),** Pan Am's parent company.

J. C. Johnston

Robert G. Reed, marketing manager for **Tidewater Oil Company's** Eastern Division since November 1958, has been promoted to assistant division general manager. Reed succeeds **I. E. Chapman** who has held the post since February 1960. Chapman has tranferred to Tidewater's Western Division in Los Angeles.

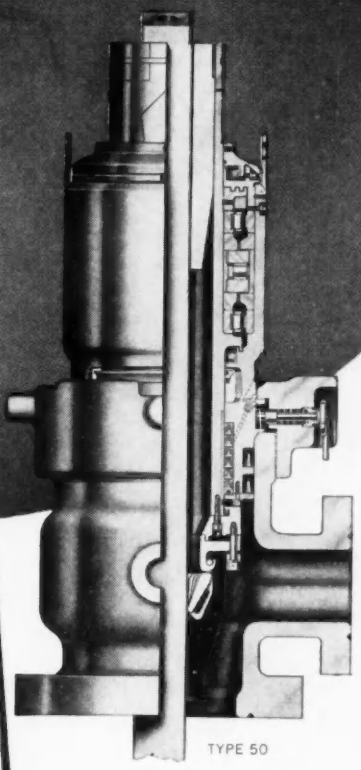
H. F. Simmons has been named division exploration manager of **Shell Oil Company's** Corpus Christi, Texas, Division. Previously division geologist in the Southwest Louisiana Division of Shell's New Orleans area, Simmons succeeds **J. H. Pittinger** who will assume a six-month assignment.

John T. Cooke will manage exploration activities in Canada for **Sohio Petroleum Company.** Cooke replaces **W. C. MacQuown, Jr.,** who is leaving the company to enter business for himself. Cooke will make his headquarters in Calgary.

In the Forefront of New Drilling Advancements...

THE SHAFFER ROTATING BLOWOUT PREVENTER

You probably saw the following news item featured in recent technical articles. In it a key role was played by the Shaffer Rotating Blowout Preventer—the blowout preventer that makes possible a wide range of new savings and efficiencies in modern drilling and production techniques...



TYPE 50

NEW DEPTH RECORD For Air-Drilling Holes Set at 18,500 FEET!

A West Texas well, bottomed at 18,500 feet, exceeded by some 2,580 feet the former record depth established by air drilling equipment. Inasmuch as the top portion of the hole was drilled with conventional fluid circulation, and the lower portion was drilled with air circulation, some interesting comparisons are available.

For example, the data shows that both the penetration rate and the bit life increased substantially with air drilling as compared to fluid drilling. However, variations in formations at the different depths make these figures interesting but not directly comparable...

During air drilling, continuous pressure control was maintained with a Shaffer Rotating Blowout Preventer. Rig report states: *"No pressure control problems were encountered while this equipment was in use."*

Average Penetration Rate:
...with fluid, 39 ft. per day.
...with air, 153 ft. per day.

Average Bit Life:
...with fluid, 68 ft. per bit.
...with air, 672 ft. per bit.*

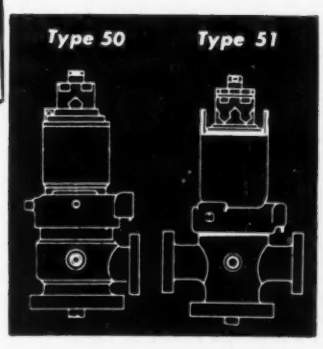
Longest Bit Run:
...with fluid, 265 ft.
...with air, 1,051 ft.*

(**Note:* The insert type bits used for air drilling cost about 5 times that of conventional rock bits, but averaged about *10* times the footage. Net difference, approximately 2 to 1!)

Available in two types...

Type 50 for drilling through 10¾" casing or larger.

Type 51 for slim-hole drilling, drilling-in, production and re-work operations.



There is no other pressure control equipment available that will handle the range or type of applications that are routine for The Shaffer Combination Rotating Blowout Preventer and Stripper.

- Here's a unit that *automatically* maintains continuous pressure seal around the drill string as long as the string is in the hole. No special drill string equipment is needed!
- The Stripper Rubber expands and contracts automatically to seal around the varying diameters of pipe, couplings, tool joints and drill collars as they pass through the unit!
- The Stripper Rubber also adjusts automatically to fit the varying *shapes* of different drill string elements—square, hexagon or octagon kellys as well as cylindrical or out-of-round shapes of pipe, couplings, tool joints and drill collars!
- The seal remains pressure-tight whether the drill string is stationary, is being rotated, or is being raised or lowered!
- The steel-reinforced Stripper Rubber is so designed that the higher the pressure the tighter the seal. Varying pressures are compensated for *automatically!*

The Shaffer Rotating Blowout Preventer is ideal for regular drilling... for drilling under pressure... for drilling with reverse circulation... and for drilling with air or gas instead of mud.

Shaffer Bulletin #1003 contains complete information on this unique blowout preventer. Your nearest Shaffer representative will gladly supply complete details. Or write direct!

37 years OF OIL TOOL LEADERSHIP

SHAFFER

HIGH PRESSURE DRILLING AND CONTROL EQUIPMENT • FISHING TOOLS THAT EXCEL

CALIFORNIA SERVICE SHOPS: Santa Fe Springs, Santa Maria, Ventura, Avenal, Bakersfield and Taft
HOUSTON, TEXAS, 6006 Navigation Blvd. • ODESSA, TEXAS, 1925 West Second Street
OKLAHOMA CITY, OKLAHOMA, Shaffer Tool Works, Post Office Box 1788
FARMINGTON, NEW MEXICO, Shaffer Tool Works, Post Office Box 827
CASPER, WYOMING, Shaffer Tool Works, Post Office Box 546
HOUMA, LOUISIANA, Shaffer Tool Works, 500 Fifth Avenue, New York, N.Y., U.S.A.
EXPORT SALES OFFICE: Shaffer Western Hemisphere, Inc., 5823 103A Street, Edmonton, Alberta.
IN CANADA: Shaffer Tool Works

Men in the industry

W. P. G. Maclachlan has recently taken over as general manager of **The Burmah Oil Company (Pakistan Trading) Limited.**

Hugh J. Davis has been appointed division landman for **Texas Gas Exploration Foreign C. A.** In his capacity as landman, Davis will supervise drilling agreements and the acquisition and maintenance of oil and gas leases for Texas Gas which recently opened offices in the Anglo American Building in Calgary, Can.

Dallas R. Lamont, vice president of research, has been elected senior vice president in charge of research and engineering of **Socony Mobil Oil Company, Inc.** In addition to research, Lamont will be responsible for the Engineering and Operations Analysis, Process Promotion and Products Departments. Lamont will continue as a Mobil director.

D. R. Lamont

J. F. Thornton has been appointed assistant district superintendent and district engineer in the Natural Gasoline Department of **Phillips Petroleum Company's** Oklahoma District at Oklahoma City.

W. J. (Jeff) Greer has been appointed manager of exploration, **Delhi Australian Petroleum Ltd.** He was promoted from his job as staff geologist for **Delhi-Taylor Oil Corporation,** Dallas. Greer will headquarter in Adelaide, South Australia, Australia.

Asa D. McRae has been named by **Mobil Oil Company** as district exploration superintendent, Midland District, Midland, Texas, replacing **H. J. Fitzgeorge** who recently transferred to New York.

William E. Fickert has been named to be in charge of the new branch office in Midland, Texas, recently opened by the **Ryder Scott Company Petroleum Engineers** and **Ryder Scott Management Company** of Wichita Falls, Texas. Other members of the two firms include: **Donald T. May, John F. Buckwalter, Richard R. Newton, G. F. Sawdy, A. L. Crawford, C. C. Shih, G. T. West, Jr., J. R. Good, T. G. Robertson** and **R. E. Lindquist.**

W. E. Fickert

Dougald Thamer has joined the **Buttes Gas & Oil Company** and has been elected to the position of secretary-treasurer.

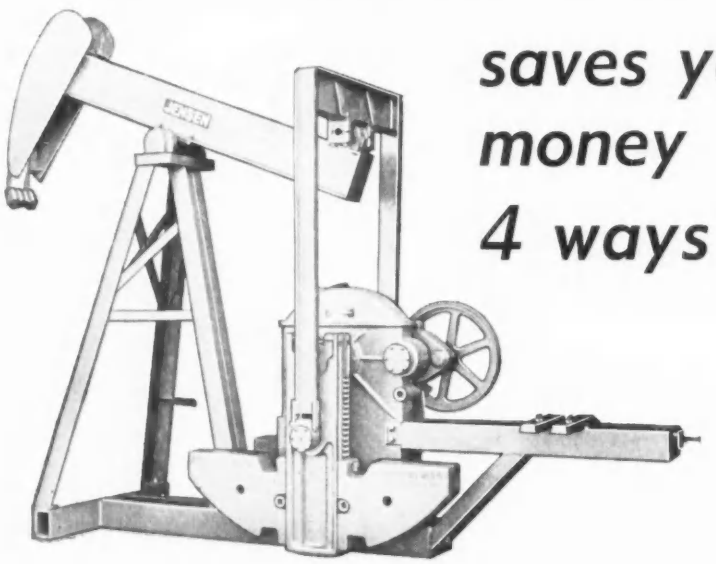
Vernon F. Hillery, former senior Texas attorney at Fort Worth for **Sinclair Oil & Gas Company,** has elected to take early retirement from Sinclair and enter private law practice. He has opened offices in the **Continental National Bank Building** in Fort Worth.

D. L. Potter, formerly superintendent of Canadian land and geological operations at Calgary, Alta., for **Phillips Petroleum Company,** has been appointed Pacific-Asiatic geological coordinator with headquarters in Bartlesville, Okla. **L. M. Richards,** former division geologist, Venezuelan operations, has been named chief geologist in Venezuela. He previously served as regional development geologist in Caracas. **J. W. Henderson,** who was chief geologist for Canadian operations for the past 10 years, transferred from Calgary to Madrid, Spain, to become Spain-Spanish Sahara exploration director for **Phillips Oil Company,** a wholly owned subsidiary of Phillips Petroleum Company.

Paul B. Greig, Jr., has been appointed division geologist for **Texas Gas Exploration Foreign C. A.**

Edwin O. Bennett, oil and gas consultant, Houston, has been awarded the **Anthony F. Lucas Gold Medal** for 1961 by the **American Institute of Mining, Metallurgical and Petroleum Engineers.** Bennett was cited for achievements in gas pressure maintenance.

JENSEN'S NEW HI-COMPACT



saves you money 4 ways!

Just check off the ways this newest of Jensen Rotary Balanced Jacks will save you money, (1) uses much less concrete for the foundation, (2) motor is well above ground, protected from dirt, grit and excess moisture, (3) uses shorter, less expensive belts, (4) easily and quickly converted to conventional engine mount.

PLUS . . . Jensen's famous one-man rotary counterbalance adjustment.

Don't wait! Investigate! NOW!

Stocked by Your Local Supply Store

Made by JENSEN BROS. MFG. CO., INC. P. O. Box 477-D, Coffeyville, Kansas

Export Office: 250 Park Avenue, New York 17, N. Y.

JENSEN – PACING THE OIL INDUSTRY SINCE 1919

JENSEN JACKS

DISTRIBUTOR FOR
Republic Steel Corporation
Pittsburgh Steel Company
The Colorado Fuel and Iron Corporation

ATLAS PIPE INC.
A DIVISION OF ATLAS BRADFORD COMPANY
3600 Yoakum Blvd. P. O. Box 66669
Houston 6, Texas Phone: JAckson 6-1901
Corpus Christi Phone: TUlip 4-6371 Tulsa Phone: DIamond 3-6791

A DIVISION OF ATLAS BRADFORD COMPANY

ATLAS PIPE INC. IS AN ORGANIZATION OF
300 PEOPLE DEVOTED TO SELLING AND SERVICING
TUBULAR GOODS FOR THE PETROLEUM INDUSTRY

Associations

J. B. Hughes Installed As Houston NOMADS President

James B. Hughes, vice president of the Hydril Company, has been installed as the 1961 president of the Houston Chapter of the National Oil Equipment Manufacturers and Delegates Society. Hughes was installed as president in January following his election to the post in mid December 1960. He succeeds John W. Gates of the Well Equipment Corporation.

Beau A. Wendt, division manager of Reed Roller Bit Company is the new vice president of the organization. Other officers include: Bruce Barkis, president of B&W, Inc., secretary; Fred A. Christanelli, public relations and sales, Baroid, treasurer; Elbert Walker, assistant export sales manager, Magcobar, executive secretary; Charles A. Doh, U.S. representative of foreign subsidiaries, Schlumberger, assistant secretary; Terry W. Russell, vice president of International Controls, Inc., assistant treasurer; Robert B. Hyde, Jr., export sales manager, Magcobar, deputy sergeant at arms; J. C. Woods, export manager, The National Supply Company, assistant deputy sergeant at arms. Ed Louden, assistant general sales manager, Baroid, B. H. Pickard and former President Gates, were installed as regents.

New Members of Los Angeles NOMADS

New regular members were inducted into the Los Angeles Chapter of NOMADS recently. Standing between Ritual Master Charlie King of Baker Oil Tools (right) and his assistant John Cochran of Driltrol, they are, left to right: Andy B. Campbell of Hillman-Kelley, James T. Streger of BJ Service, James E. Sayers of Smith Tool Company and Donald J. Dunlop of Baker Oil Tools.

OILFIELD TRANSPORTATION EQUIPMENT

OILFIELD TRUCK AND FLOAT

Thornycroft Sandmaster 252" wheel base Oilfield Truck. Hands-England full Oilfield Body. 60,000 lb. winch, heavy duty gin poles, winch operated gin pole risers and folding SAE king pin.

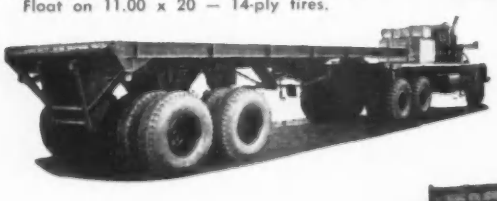
Hands-England 75,000 lb. capacity, tandem axle Oilfield Float 30' 0" long and 9' 6" wide, folding support legs and inverted 36" fifth wheel.

Truck and Float on Michelin 18.00 x 25. Sahara "X" sand tires.

OILFIELD FLOAT

Hands-England 75,000 lb. capacity tandem axle Oilfield Float 30' 0" long and 8' 6" wide, folding support legs and inverted 36" fifth wheel.

Float on 11.00 x 20 — 14-ply tires.



OILFIELD TRUCK AND FLOAT

Scammel Constructor 261" wheel base Oilfield Truck.

Hands-England 75,000 lb. capacity tandem axle Oilfield Float 30' 0" long and 9' 6" wide folding support legs and inverted 36" fifth wheel.

Truck and Float on 14.00 x 20 — 18-ply tires.

OILFIELD FLOAT

Hands-England 25,000 lb. capacity single axle Oilfield Float 24' 0" long and 8' 0" wide, folding support legs and SAE king pin 11.00 x 20 — 12-ply tires. Steel stake sides.

HANDS-ENGLAND OILFIELD EQUIPMENT LTD. Works Road, Letchworth, Herts., England

Telephone: Letchworth 600 Telegrams: Oil, Letchworth. Cables: Oil, Letchworth, England BMJ

Four New Members Elected To PESA Board of Directors

Four new members of the board of directors of the Petroleum Equipment Suppliers Association have been elected and a new Pacific District chairman has been designated.

New directors from the Gulf Coast District are Paul F. Carmouche, Murray-Brooks, Inc., Lake Charles, La.; J. T. Kennedy, Houston Oil Field Material Company, Inc., Houston, and W. E. Scarborough, Reed Roller Bit Company, Houston. The new director from the Pacific District is Elber J. Weis, Pacific Pumps, Inc., Huntington Park, Calif.

The new Pacific District chairman is H. H. Peters, Technical Oil Tool Company, Los Angeles. Peters is a member of PESA's executive committee and replaces W. A. Wilson, who resigned as director and chairman of the Pacific District.

Abilene Geological Society Announces New Officers

The Abilene Geological Society of Abilene, Texas, has announced new officers for 1961. They are Jack B. Ryan, Jake L. Hamon, Oil Producer, president; Harold C. Beaird, Lone Star Producing Company, vice president; Doyle H. Elich, Champlin Oil & Refining Company, secretary, and Jimmy W. Sojourner, West Central Drilling Company, treasurer.

Kent Waddell, Coastal States Gas Producing Company, was named Southwestern Federation of Geological Societies representative, and Robert B. Vickers, Texas Pacific Coal & Oil Company, was named an alternate representative for the SFGS.

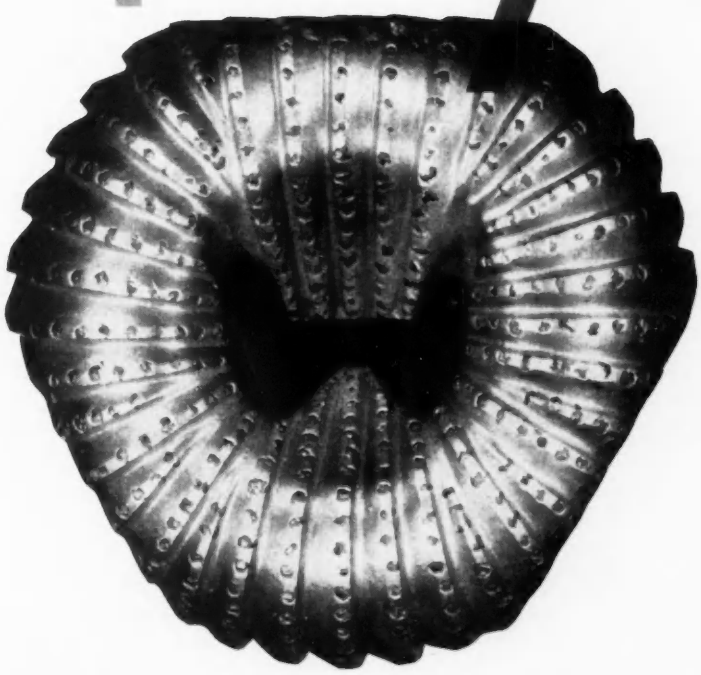
WHO'S MEETING WHERE

Feb. 2	PESA, South Mid-Continent District, Statler Hotel, Dallas.
5–10	ASTM Committee D-2 Meeting, Benjamin Franklin Hotel, Philadelphia, Pa.
7	PESA, Gulf Coast District, Shamrock Hilton Hotel, Houston.
8–10	The Southwestern Legal Foundation, Twelfth Annual Institute on the Law of Oil Gas, and Taxation, Southwestern Legal Center, Dallas.
9–10	New Orleans Regional Conference on Employe Communications, Committee on Public Affairs (API), Roosevelt Hotel, New Orleans.
–14	PESA, Eastern District, Duquesne, Pittsburgh.
–16	Dallas Regional Conference on Employe Communications, Committee on Public Affairs (API), Sheraton-Dallas Hotel, Dallas.
20 Thru Mar. 11	Advanced Drilling Practices Course for Engineers, The University of Oklahoma, Norman.
26 to Mar. 2	AIME Annual Meeting, Penn-Sheraton Hotel, Pittsburgh, Pa.
26 to Mar 2	Society of Petroleum Engineers of AIME Annual Meeting, Chase & Park Plaza Hotels, St. Louis, Mo.
28 Thru Mar. 1	New York Regional Conference on Employe Communications, Committee on Public Affairs (API), Park-Sheraton Hotel, New York City.
Mar. – 2	PESA, North Mid-Continent District, Mayo Hotel, Tulsa.
– 5	Sixth Annual Gas Turbine Conference and Products Show, Shoreham Hotel, Washington, D.C.
– 7	PESA, Pacific District, Ambassador Hotel, Los Angeles.
5– 9	ASME Gas Turbine Power Conference & Exhibit, Co-Sponsored by U.S. Department of Defense, Shoreham Hotel, Washington, D.C.
8– 9	Chicago Regional Conference on Employe Communications, Committee on Public Affairs (API), Sheraton-Towers Hotel, Chicago.
8–10	API Division of Production, Southern District Meeting, Captain Shreve & Washington-Youree Hotels, Shreveport, La.
13–17	National Association of Corrosion Engineers, Annual Meeting & Corrosion Show, Hotel Statler, Buffalo, N.Y.
22–24	API Division of Production, Southwestern District Meeting, Cole Hotel, Albuquerque, N.M.
27–29	Midwest Gas Association, Annual Meeting & Convention, Sheraton-Fontenelle Hotel, Omaha, Neb.
30 Thru April 1	Fourth Symposium on Rock Mechanics, Pennsylvania State University, University Park, Pa.
April 4– 5	Gas Compressor Institute, Southwest Kansas Center, Liberal, Kan.
5– 7	API Division of Production, Mid-Continent District Meeting, The Mayo Hotel, Tulsa.
9–11	SEG, Fourteenth Annual Mid-Western Meeting, Skirvin Tower Hotel, Oklahoma City.
9–13	ASME Oil & Gas Power Conference & Exhibit, Jung Hotel, New Orleans
11–13	PESA & PIEA 1961 Conference and Exhibit, Galveston, Texas.

Nomad's Chapter monthly meeting: Los Angeles, second Wednesday, Biltmore Hotel, Wallace A. Sawdon, Secretary. Houston, second Monday, Ye Old College Inn, Elbert T. Walker, Secretary. Dallas-Fort Worth, first Monday, Greater Dallas Club, Hank Davis, Secretary. Tulsa, Totel Tulsa, Gilbert Swift, Secretary. New York, first Monday, Hotel Biltmore, Jesse E. Hickman, Secretary.

HYCALOG
CONTINUING RESEARCH FOR LOWER COST DRILLING

Triples
Triples
Triples FT/HR



With no increase in bit cost !

NO RECORD FOR THE PC-91 diamond bit, this stepped up penetration rate is typical where formation characteristics are suitable. Similar drilling speeds have been achieved in south Louisiana, south Texas, and northwest Colorado. Long runs have held bit costs to no more than if conventional rock bits were used. And the saving in rig time, which one driller estimated at $15,000 on a single bit, *is all yours!*

Ask your HYCALOG *rep for actual performance records. Or better yet, let a* HYCALOG *bit set a record for you.*

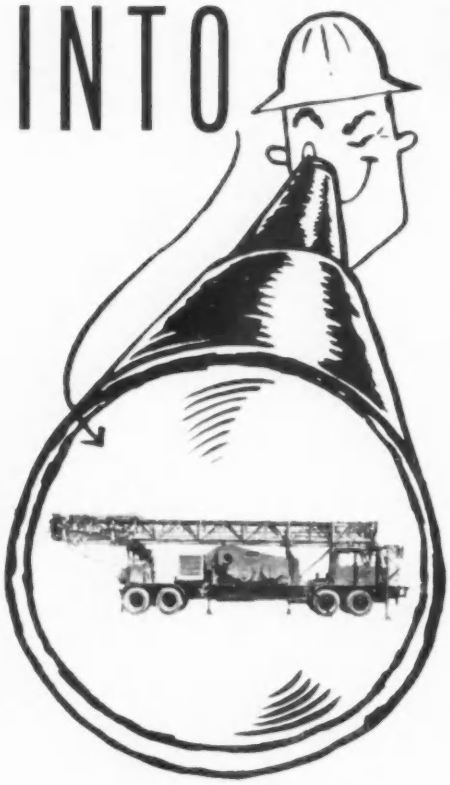
HYCALOG, INC.

505 AERO DRIVE, SHREVEPORT, LOUISIANA.

OFFICES IN PRINCIPAL OIL PRODUCING AREAS

DIAMOND BITS • CORE BARRELS • WELL LOGGING • DIAMOND CORING • CORE ANALYSIS • POWER SWIVELS

WORTH LOOKING INTO



Get the facts about—

WINCHMOBILE

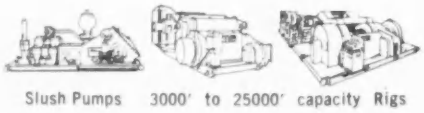
Before you buy get the facts on light weight...low cost...long life Wilson Winchmobile with the cross mounted engine which saves moving parts and increases hp to the drum by 20%!

Wilson

WILSON MFG. CO., INC.

Wichita Falls, Texas • The Home of RED IRON

Winchmobiles Traveling Blocks Speedwinches



Slush Pumps 3000' to 25000' capacity Rigs

Suppliers' notes

F. J. Nunlist

D. C. Power

Donald C. Power, chairman of the board and chief executive officer of General Telephone and Electronics Corporation, and **Frank J. Nunlist,** vice president, Operations, Worthington Corporation, have been elected to the board of directors of **Worthington Corporation.** The two new directors will fill vacancies resulting from the retirement of **Lewis L. Clarke** and **Hunter S. Marston.**

Jean-Didier Herrenschmidt has been elected president and general manager of **Ken International S.A.,** and **Pierre Jouse** has been appointed assistant manager. Both headquarter at the Paris (France) offices of the company.

R. T. Watkins has been appointed area manager of machinery sales in Los Angeles for the **Oil Well Supply Division of U.S. Steel Corporation. J. W. Etheredge** was appointed field representative at Hobbs, N. M., and **King D. Boyd** was transferred from Caracas, Venezuela, to Dallas as sales representative.

G. D. Duke has been appointed service manager for **Johnston Testers, Inc.**

Kenneth W. Robbins has been appointed northern regional manager for **Otis Engineering Corporation.** Robbins will also retain his duties as director of export sales and services. He will be in charge of Otis' sales and service offices in the northern half of Texas and Louisiana as well as those located in Oklahoma, Kansas, Colorado, Alabama, Mississippi, New Mexico and Wyoming.

K. W. Robbins

Joe T. Gailus, manager line pipe, **Continental-Emsco Company,** will now also be in charge of non ferrous pipe sales. Also, **Leslie D. Murphy,** former assistant manager oil country tubular sales, is now manager, Tubular Administration Department.

J. L. Leimbrook, formerly assigned as salesman at Farmington, N. M., for **Jones & Laughlin Supply Division,** has been transferred to the Houston sales office. Also, **T. D. Gholson,** formerly assigned at Houston, has been appointed resident salesman at Jackson, Miss.; **D. T. Henderson,** salesman at Shreveport, La., is now resident salesman at Monroe, La., and **Haney Atyia,** previously salesman at Midland, Texas, is now assigned as field salesman at Midland.

Shuman Succeeds McKinney As National Supply Head

Sidney A. Shuman has been elected vice president and general manager of National Supply Division, Armco Steel Corporation subsidiary, succeeding Arthur W. McKinney who has retired as president.

Shuman, a native of Oklahoma, has been active in the oil and oil supply industries since 1925. In 1936, he joined the Fluid Packed Pump Division of National Supply and rose to the position of general manager. In early 1960, Shuman was transferred to Pittsburgh and became assistant to McKinney.

A. W. McKinney

S. A. Shuman

McKinney climbed from a salesman's job in 1920, to the presidency of The National Supply Company in 1954. During World War II, he served as a member of the Industry Advisory Council, Petroleum Administration for War and as a member of the Materials Subcommittee of the Petroleum Industry War Council. In addition to holding the presidency, McKinney has served as a member of the board of directors of The National Supply Company, and of Oil Well Engineering Co., Ltd., an English firm, and of Fretz-Moon Tube Company, both of which are half-owned by National Supply. McKinney will continue to serve as consultant to and member of the board of directors of Armco Steel Corporation.

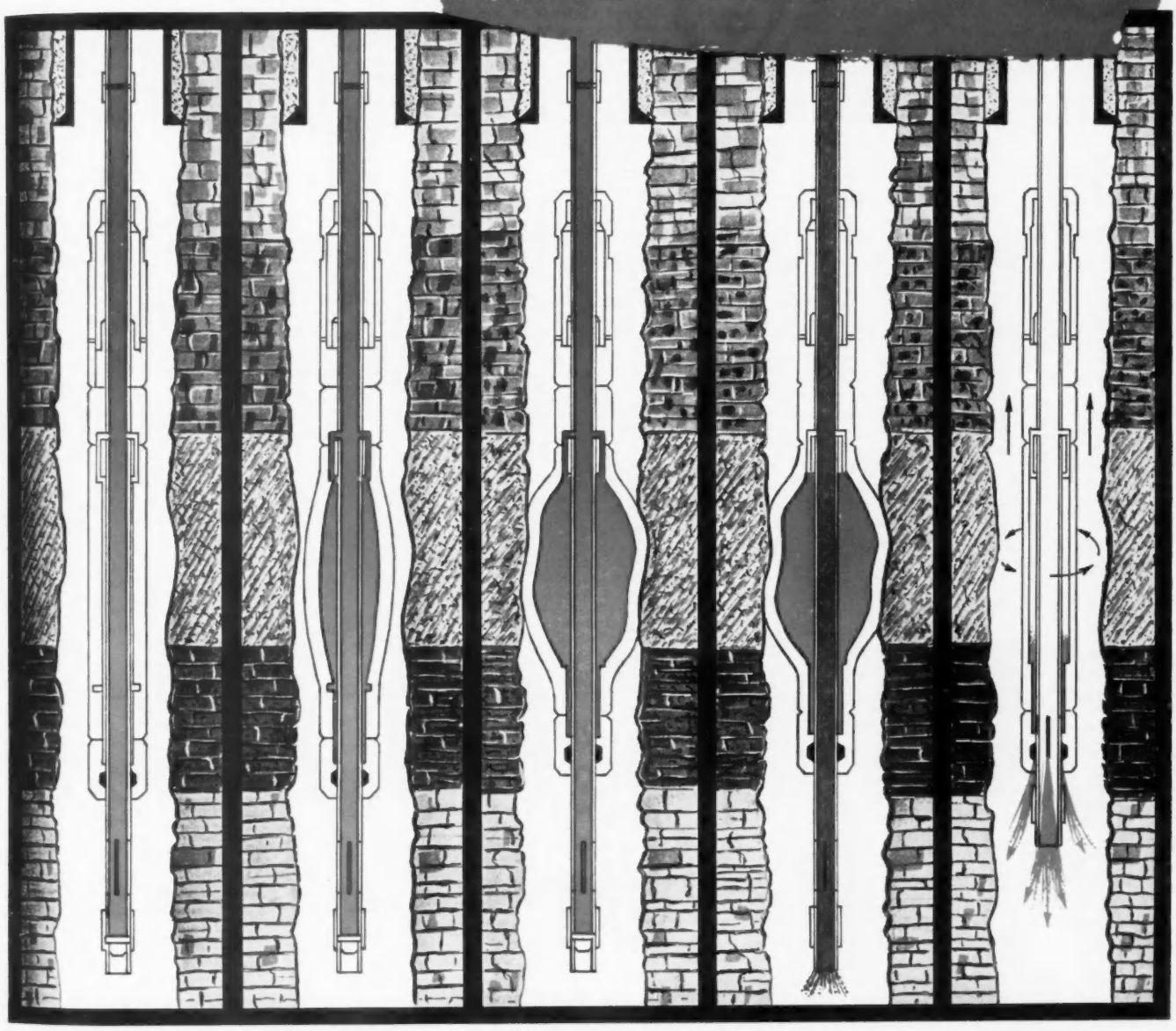
Glamorgan Plastics Announces Production Facilities Expansion

Glamorgan Plastics, a Division of Glamorgan Pipe & Foundry Company, has announced an expansion of 50 percent in its production and warehouse facilities at its main plant in Lynchburg, Va.

According to the announcement, with Glamorgan's entry into other fields such as irrigation, conduit, sewer and drain pipe, earlier than originially expected, an expansion was necessary at this time.

HOW LYNES "PIP" PACKER SEALS IN OPEN HOLE OR CASING

The simple, positive operation of the Lynes inflatable "PIP" packer makes every driller a packing expert. Setting is merely a matter of running the tool into the hole on tubing or drill pipe to the exact depth desired and pressuring up on the pumps. The steel reinforced rubberized sealing element expands up to twice its run-in diameter to effectively seal in open hole or in casing. The sealing element is 53 inches long.



Here's How It Works

Make up "PIP" Packer on tubing string with knock-out or rupture disk in bottom. Run to desired setting depth.

Fill string with fluid. Pressure-up on fluid.

Packers for use in casing have "friction grip" elements with metallic particles imbedded in the rubber cover to produce high anchoring friction against the casing.

Check valves in ports open under pressure and sealing element inflates. Check valves hold pressure in sealing element when pressure in string is released.

Sealing element grips bore or casing wall and will hold against high differentials from above or below without weight on string.

To open below packer, knock out disk with sinker bar or increase pump pressure to rupture disk.

To release packer, rotate string to right, pull up 1½ feet. Fluid escapes from inflated sealing element along grooves on mandrel. Wait 15 minutes and pull out of hole.

Available in sizes 3½" through 5⅝" to seal in holes up to 11".

LYNES, INC.

P. O. Box 12486 Houston 17, Texas

SALES LOCATIONS

Pampa • Midland • Wichita Falls
Oklahoma City • Carmi • Prestonburg, Ky.
Mt. Pleasant, Mich. • Calgary • Edmonton

Suppliers' notes

Plastic Applicators, Inc. Opens Louisiana Plant

Plastic Applicators, Inc., of Houston has recently opened a new $250,000 plant for applying Plasticap coatings to the internal surfaces of oil field tubular goods. The new plant is located in Morgan City, La., and is the only baked-on plastic coating plant with barge-handling facilities. Planned and located on a nine-acre site with 750-foot water frontage for the convenience of offshore operators, the plant is also accessible by truck or rail.

The plant covers 29,000 square feet and increases Plastic Applicator's pipe-coating capacity 25 per cent. It is located on Bayou Boeuf near Morgan City.

Company officials said that the plant was built to meet an increased demand for Plasticap coatings and to improve the service offered to the firm's customers. Plastic Applicators has sales and service offices in Shreveport, Lafayette, Houma, Morgan City, and New Orleans, La.; Jackson, Miss.; Houston, Midland, Dallas, Odessa, and Corpus Christi, Texas; Hobbs, N. M.; and Tulsa.

Bradford Supply Company Announces Oklahoma Location

Bradford Supply Company, a division of Atlas Bradford Company, announces that Hennessey, Okla., is the location of the newest store for the company.

The store will serve the area as a sales and stocking point for all types of drilling and production equipment. Troy Tipton, who had managed the store at Ada, Okla., will be in charge of the new outlet. Salesmen assigned to the new store are W. E. Swafford and Max Nelson who will handle inside sales.

SEND FOR YOUR ANNUAL EDITORIAL INDEX NOW

WORLD OIL's annual Editorial Index, covering all the issues published during 1960, is now available to all WORLD OIL readers. Bound in convenient pamphlet form, this handy and useful index will be sent FREE to all subscribers requesting copies. What special issue or article did you forget to save? Well, no need for worry, the 1960 Editorial Index refreshes your memory.

Make sure you get your copy FREE of charge. Address your order to: Librarian, Gulf Publishing Company, Post Office Box 2608, Houston 1, Texas. If you prefer, use the convenient Readers' Service Blue Postcard just inside the back cover of this and every issue of WORLD OIL. Just check the square indicated, fill in your name and address and drop postpaid card in the mail. The annual WORLD OIL Editorial Index will be sent to you FREE by return mail. Don't delay. Do it now. The supply is limited.

WORLD OIL'S Trading Post CLASSIFIED ADVERTISING

RATES: Regular Classified (undisplayed) set in this size type: 20 cents per word. Minimum charge $4. Blind box address in our care counts six words. Replies forwarded without charge. Display Classified ads, set in suitably larger type with ruled border, $13.50 per column inch. Ten percent discount for two or more insertions of same copy in consecutive issues. All classified ads payable in advance. Send copy and checks to: Trading Post Classified Section, World Oil, P. O. Box 2608, Houston, Texas.

FOR SALE

■ SALES AND RENTALS. New or used portable floating bridges, trestle bridges and ferrys. Bub Gallaway, 4106 Ascot Lane, Houston, Texas. Phone OV 2-2334.

■ Portable Spudder. Cooper E563 excellent condition, on IHC truck. Inventory available. Box 736, Great Bend, Kansas, Phone GL 3-8817.

Blackmer Rotary Pumps

All bronze with 25/12.5 H.P. G.E. Electric Motor. Totally enclosed Fan Cooled. For heavy liquid handling; will pump under 50 lbs. pressure with 10′ lift—gasoline, kerosene, thinner, fuel oil, cotton seed oil, lube oil, vegetable oil, mineral oil, etc.

Brand new Blackmer Rotary Pump, #1N401-NV. Rated 400 G.P.M. at 420 RPM, 200 G.P.M. at 210 RPM. Has 4″ Am. Std. Flange inlet and outlet. Equipped with internal relief valve. Pump is mounted vertical on welded steel base. Has horizontal inlet and outlets driven by G.E. frame 405C, 25/12.5 HP 2 speed Vertical Gearmotor, 3 phase 60 cycle, 440 volt (will reconnect for 220 volt).

Includes G.E. 25/12.5 HP 2 speed Controller 3/60/440 24″ x 24″ x 11″ in weatherproof enclosure. Pump and motor 24 x 30 x 70″ high.

U.S. NAVY ACQ. COST approx. $2500—Our price $850.00 F.O.B. N. Tonawanda, N.Y. Shipping weight approximately 3,000 lbs. 22 available

NOTICES, SERVICES

■ Oil Field Tools and Equipment Sales Representation for American manufacturers, offered for Italy and North Africa especially, by Italian Engineer, retiring from large Company. Highest References Italy and U. S. Address Box No. 221-W, c/o WORLD OIL, Houston, Texas.

■ FINANCIAL—Investment Banking Houses and Underwriters reached. Confidential. You can send the details of your proposition direct or thru your attorney to Consultant 817 - 51st Street, Brooklyn, N. Y.

FOR RENT

ALDRICH PLUNGER PUMPS
Skidded with Drivers
Available for RENTAL
POWER SPECIALTY CO.
2000 Kipling St.
HOUSTON 6, TEXAS

HELP WANTED

HUMBLE OIL & REFINING COMPANY
CENTRAL REGION
(Formerly Carter Division)

has production engineering openings for Mechanical, Chemical, Petroleum, Electrical, Civil and other graduate engineers with up to five years' experience. Salary and first assignment dependent upon experience and qualifications of applicant. Send complete resume of educational background, work experience, and personal history, including a copy of college transcript to Employment Office, Room 738B, Box 801 Tulsa, Oklahoma.

LEASES, DRILLING, ACREAGE, ETC.

NEW MONTHLY LEASE REPORT

Bureau of Land Management in New Mexico offers land each month for oil leasing. New monthly air mail gives you continuous geologic evaluation of recommended parcels for only $10 a month. Such material gives information needed to directly participate.

G. R. GUINTANA & ASSOCIATES
Consulting Geologists
P. O. Drawer 1666 Santa Fe, New Mexico

WORLD OIL
Classified Ads
Don't Cost . . . They Pay

3 heads are better than 1 . . .

Often a utility electric power company engineer enters into a decision with one or more oil company engineers . . . effecting the economy of operation. This assistance is available anytime to oil producers, pipeline personnel or refinery engineers. As a matter of interest the triple pumper in the photograph pumps simultaneously from three producing zones.

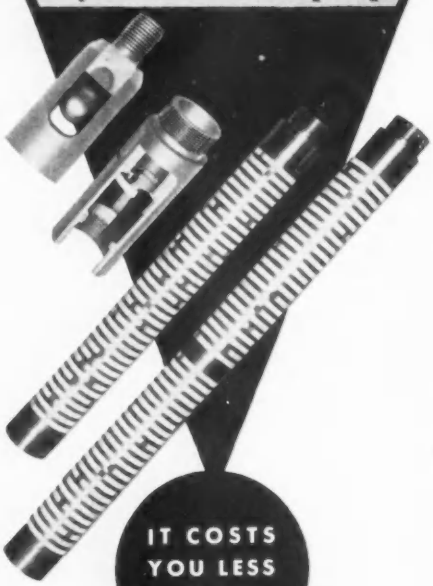
Petroleum Electric Power Association
BOX 35006, DALLAS 35, TEXAS

Utility Electric Power saves money, manpower, maintenance and serves you better automatically

A list of P.E.P.A. members will be furnished on request

Let R-u-b-b-e-r Take The Wear

in your sucker rod pumps



IT COSTS YOU LESS THAT WAY

! MARTIN RUBBER & DUCK RINGS give excellent life in dirty abrasive fluids . . . high or low gravity . . . much or little water . . . shallow or deep wells. They last for years in the easier pumping wells. Replacement rings cost comparatively little.

! MARTIN PLUNGER BODIES, precision grooved, drilled and threaded (no underneath fluid passage), usually last for years. Tube or barrel costs are often cut in half.

! The replaceable SYNTHETIC RUBBER GUIDES in MARTIN CAGES last longer than any metal, and the cushioning of the ball increases your ball & seat life. Results are often truly amazing. (Patent No. 2,591,174)

Write for our new catalog or see it in the Composite (24th Edition). All products sold thru supply companies.

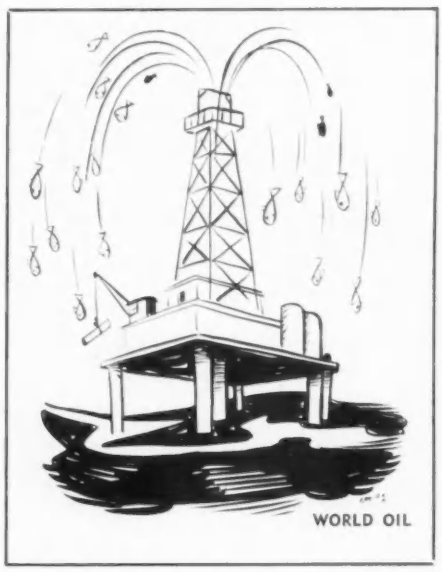
JOHN N. MARTIN

Manufacturer

9 W. BRADY STREET • TULSA, OKLAHOMA

SQUEAKS

From the Bull Wheel



WORLD OIL

Sign of the Times

Sign in the window of a launderette: "Ladies who care to drive by and drop their clothes will have prompt and courteous attention."

Ah, Tranquilizers

Joe was having trouble getting up in the mornings, so his doctor prescribed some pills. Joe took them, slept well and was awake before he heard the alarm. He took his time getting to the office, strolled in and said to his boss: "I didn't have a bit of trouble getting up this morning."

"That's fine," replied his boss, "but where were you yesterday?"

Something Soothing

Doctor: "To settle your stomach, drink a glass of hot water every morning."

Engineer: "I've been doing that for years, Doc. My wife calls it coffee."

Shocking Results

"Was your friend shocked over the death of his mother-in-law?"

"Shocked? He was electrocuted."

Anything for a Buck

The haughty senior girl sniffed disdainfully as the freshman cut in during a dance at the prom. "And just why did you have to cut in when I was dancing?"

The freshman hung his head and slowly replied: "I'm sorry ma'am, but you see, I'm working my way through college and your partner was waving a $5 bill at me."

Hoot Mon—Beware

A party of clergymen were attending a Presbyterian conference in Scotland. Several of them set off to explore the district. Presently they came to a river spanned by a temporary bridge. Not seeing the notice that said it was unsafe, they began to cross it. The bridge keeper ran after them to protest.

"It is all right," declared the spokesman, not understanding the reason for the old man's haste, "we're Presbyterians from the conference."

"I'm no' caring aboot that," was the reply, "but if ye dinna get off'n the bridge ye'll be Baptists!"

SECONDARY RECOVERY

PETROLEUM ENGINEERS
STEPHENS ENGINEERING
WICHITA FALLS, TEXAS

RESERVOIR ENGINEERING

Water Flooding — Gas Repressuring

EVALUATION — CORE ANALYSIS

SURVEYS — ECONOMICS

Cost Estimates, Design, Installation

FIELD SUPERVISION

Phone 723-2167

CUT STUCK SAND LINES INSIDE TUBING

KINLEY SAND LINE CUTTER

J. C. KINLEY CO., Licensees

ABILENE, TEXAS	
Eads Engineering Services, Inc.	OR 2-8655
ABILENE, TEXAS	
Dunnam Service & Equipment Co.	OR 2-5331
ABILENE, TEXAS—Hudson-Eads, Inc.	OR 2-5331
BAY CITY, TEXAS—J. P. Graham	CI 5-4526
CASPER, WYOMING—C. A. White	3-5264
FULLERTON, CALIFORNIA—Dyna-Log.	LA 6-1184
GLENDIVE, MONTANA—C. A. White	EM 5-3833
HOBBS, NEW MEXICO	
Horne Well Service Co.	3-5396
KILGORE, TEXAS	
Davis-Kemp Tool Co., Inc.	3541
LIBERAL, KANSAS—Rainbo Service	Main 4-3560
LINDSAY, OKLAHOMA	
Rainbo Service Co.	PL 6-2530
MIDLAND, TEXAS	
Luccous Service & Eqpt. Co.	MU 2-8311
NATCHEZ, MISSISSIPI	
Davis-Kemp Tool Co., Inc.	2-3021
NEW IBERIA, LOUISIANA	
Klein-Deco Wire Line Service	EM 9-6632
OKLAHOMA CITY, OKLAHOMA	
Rainbo Service Co.	ME 4-2131, ME 4-0105
STERLING, COLORADO	
Cable Drilling, Temp. & Well Serv. Co.	LA 2-4781
VIDALIA, LOUISIANA	
Davis-Kemp Tool Co., Inc.	ED 6-4224
WHITTIER, CALIFORNA	
Kline Wire Line Co.	OX 3-2731
WICHITA FALLS, TEXAS	
Eads Engineering Services, Inc.	766-0931
WICHITA FALLS, TEXAS	
Hudson-Eads, Inc.	322-8584
WILLISTON, N. DAKOTA	
C. A. White	GR 3-6555

TO HELP YOU NET MORE PROFIT

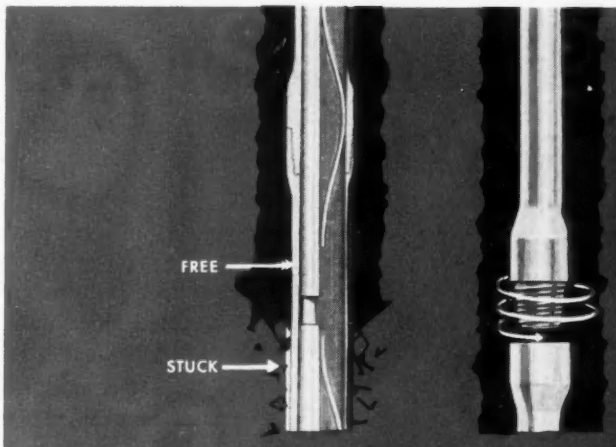
McCULLOUGH® *Wire Line* PIPE RECOVERY SERVICE

This great "team" of wire line pipe recovery tools will save you time, pipe and money – help you net more profit from your drilling or remedial operations.

These tools are fast and efficient, enabling you to recover a maximum amount of free pipe before resorting to washover and mechanical fishing operations. Even during washover operations, their use assures you of the fastest most economical recovery of the balance of the stuck pipe.

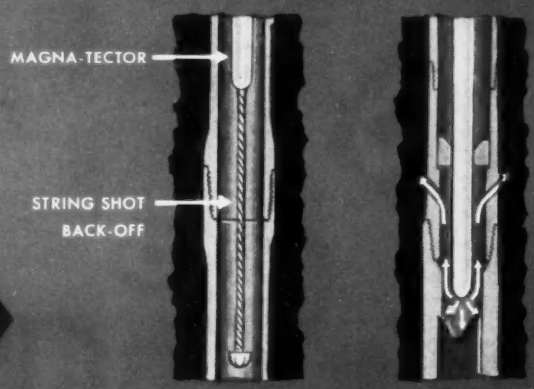
For economy's sake – for efficiency's sake – for the sake of a more profitable operation – call McCullough on your next stuck pipe job. You'll be spinning your table again in "no-time".

McCullough
TOOL COMPANY
Los Angeles • Houston • Edmonton
Cable Address: MACTOOL



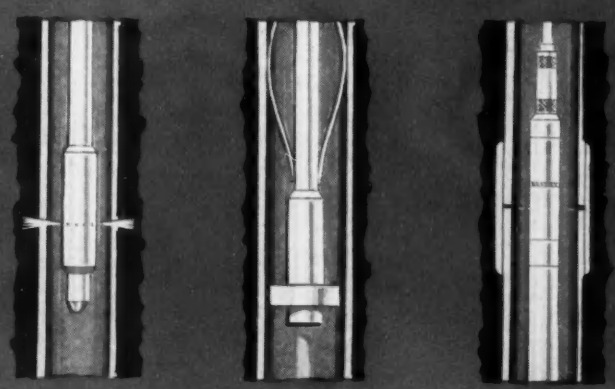
McCullough
MAGNA-TECTOR®
Locates lowest free point in stuck pipe with extreme accuracy. Used in drill pipe, drill collars, tubing and casing.

McCullough
STRING SHOT BACK-OFF
Loosens lowest free joint (located by Magna-Tector) by a vibratory shock wave, allowing pipe to be easily unscrewed.



McCullough
"ONE TRIP" BACK-OFF
A combination of Magna-Tector and String Shot Back-Off which performs entire back-off operation on a single run. Available in most areas.

McCullough
HYDRAULIC CLEAN-OUT TOOL
A wire line tool that will clean out debris, sand and bridges from the ID of drill pipe, drill collars or tubing prior to, or during pipe recovery operations.



McCullough
CHEMICAL TUBING CUTTER
Cuts tubing in a split-second. Makes a burr-free, flare-free cut.

McCullough
JET CASING CUTTER
Makes a clean, circular cut with a high velocity beam of jet gases.

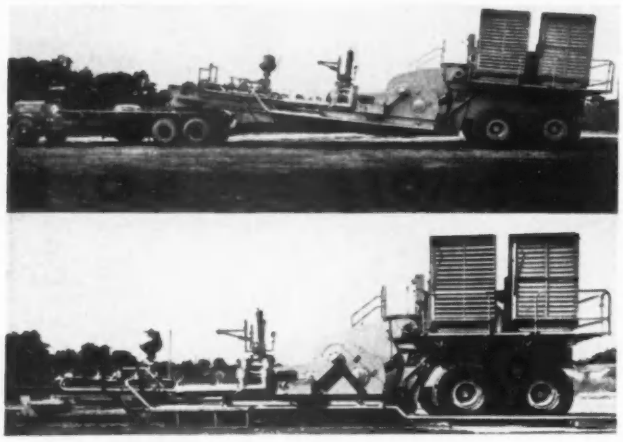
McCullough
MEASUREMENT CONTROL
Accurate collar and tool joint depth locating on every run.

For more data on advertised products, use Readers' Service Cards, last page.

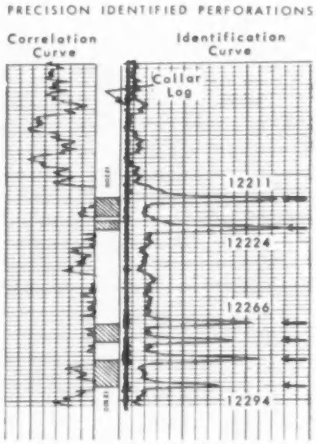
NEW equipment and services

New Rock-Over Trailer

This new "Rock-Over Trailer" has two engines and two pumps. Design makes it possible for the pump to operate with the pump suction low and with the trailer frame, or master skid, resting on the ground. Design permits trailer-mounting of the mud pumps complete with suction and discharge manifold and engines. Since trailer frame rests on the ground, the forward end makes an ideal location for the centrifugal pump. (Mid-Continent Supply Co. Supplements data on Pages 3689-3756, 1960-1961 Composite Catalog).



For more data, circle E1 on postcard



New Perforations Log

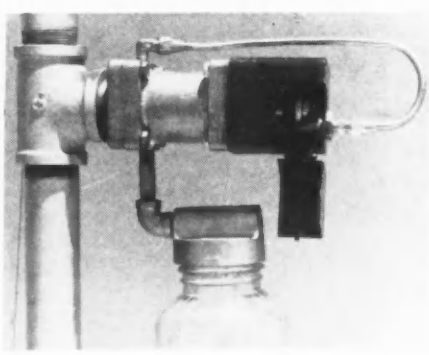
This Precision Identified Perforations Log confirms the placement of shaped charged perforations with respect to the productive zone. This new method employs special shaped charges fired at top and bottom of the perforated interval. Charges leave traces of radioactive material within the perforations which are indicated by sharp peaks on the gamma ray recording run after perforating. (Schlumberger Well Surveying Corp. Supplements data on Pages 4849-4868, 1960-1961 Composite Catalog).

For more data, circle E2 on postcard

Improved Packing

An improved packing for Hercules and Ratigan stuffing boxes, recently made available by the Marlo Company, Inc., features a vitalizing, antifrictional, semi-metallic insert which creates an exceptionally smooth and resilient packing surface. The insert absorbs oil and acts as a lubrication reservoir, adding to the life of the packing even under the most unfavorable conditions. (Axelson Division of U.S. Industries, Inc. Supplements data on Pages 269-340, 1960-1961 Composite Catalog.)

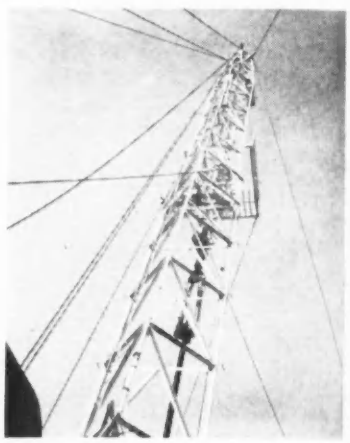
For more data, circle E3 on postcard



Automatic Sampling Device

This new automatic sampling device works in conjunction with all types of metering equipment for determining the BS&W content in the fluid as it comes from the well. This is a completely automatic device with several new features to assure a more representative sample of fluid. There are no valves or springs in the sampling portion resulting in less chance of failure during the sampling cycle. (Miller Sales and Engineering Co.).

For more data, circle E4 on postcard



New Telescoping Derrick

This new, triangular, telescoping derrick has been designed to provide greater strength with less weight. Minimum guying is required and greater speed of operation is obtained with automatic features. Tri-Scope derrick allows significant weight reduction with the elimination of a fourth leg. The crown is positioned on the derrick so that all three legs are working legs—such as with a tripod. This provides maximum column capacity to be realized for any particular leg section. (Cabot Corporation, Machinery Division. Supplements data on Pages 1065-1074, 1960-1961 Composite Catalog).

For more data, circle E5 on postcard

Oil Field Lubricants

A complete line of custom-built oil field specialty lubricants, offering great heat, acid and wear resistant qualities is now available. Lubricant contains Almasol lubricative pigment which offers these advantages: tremendous load-carrying strength; low coefficient of friction; chemical inertness; natural affinity for metals; long wear life, and retains these important characteristics without change, up to 1,900 degrees Fahrenheit. (Lubrication Engineers Inc.).

For more data, circle E6 on postcard

Sulfate reducing bacteria, cause of corrosion that penetrated this brine line, can now be controlled. New Visco Formulas prevent this attack, in brine, as effectively as in fresh water systems.

In Waterflooding: Strict Control of Sulfate-reducing and Sulfide-producing Bacteria In Brine as well as Fresh Water Systems.

STOPS ➤ **Pitting Corrosion**
Iron Sulfide Sludge Formation

Controlling sulfate-reducing and sulfide-producing bacteria in fresh or brine water injection systems is an integral part of Visco treatment for waterflooding . . . along with efficient clarification, scale prevention and corrosion control.

Effective, *economical* control of sulfate-reducing *and sulfide-producing* bacteria in waters of high chloride content is a new development in water treatment practice . . . one you should certainly investigate if control costs are running high—or effectiveness is less than excellent Write or call for action today.

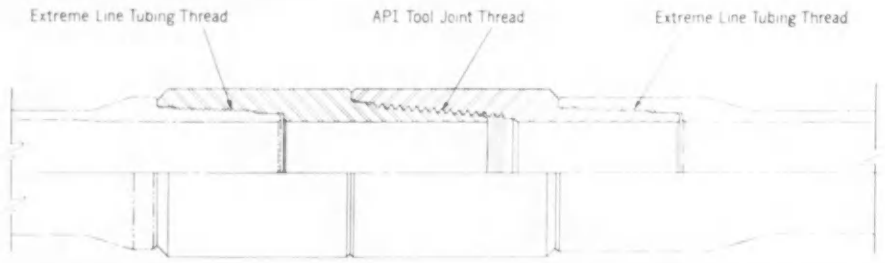
VISCO PRODUCTS COMPANY
Incorporated
A Unit of Nalco Chemical Company
1020 Holcombe Boulevard **Houston 25, Texas**

Visco

. . . SERVING THE PETROLEUM INDUSTRY THROUGH PRACTICAL APPLIED SCIENCE

Visco CHEMICALS
Visco SERVICES

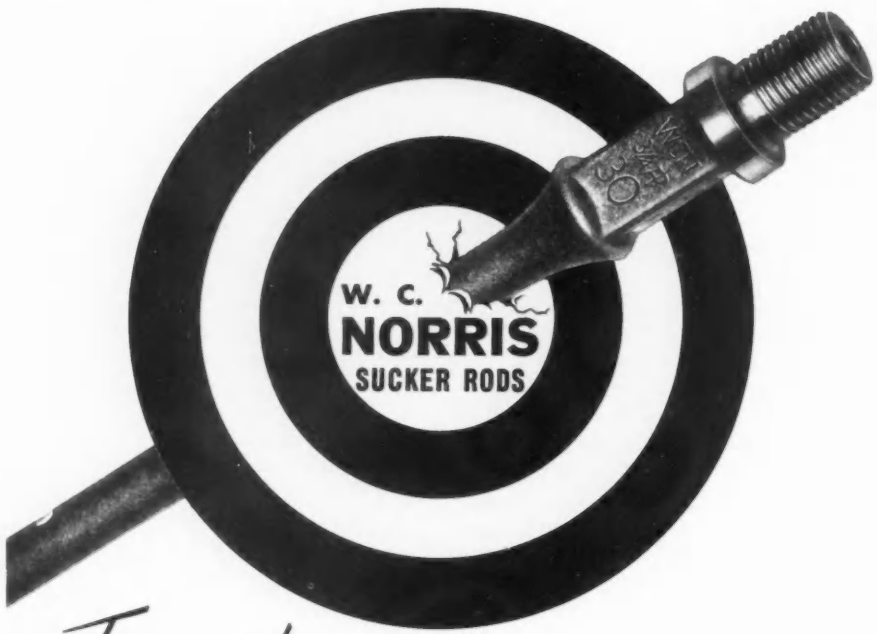
New equipment



Line Tubing Tool Joints

Tool joints for Extreme Line tubing, designed for use in workover, completion and deepening jobs, are now available from the manufacturer. Rotary connection is the standard API internal flush box and pin. This ensures interchangeability, particularly where subs and other API connections are used, and simplicity, if and when remachining may be necessary in field machine shops. Advantages: round-trip time is shortened, joints take all "hammer and tong" wear and rotary threads take all "make-and break" wear. (The National Supply Co. Supplements data on Pages 3849-3976, 1960-1961 Composite Catalog).

For more data, circle E7 on postcard



Target **Longer Service**

TYPE 30 Carbon-Manganese fully normalized. For heavy duty where corrosion is not a major problem.

TYPE 40 Nickel-Molybdenum Alloy. Normalized and tempered. For heavy duty pumping in medium corrosive conditions.

TYPE 75 Nickel-Chromium-Molybdenum Steel, normalized and tempered. For extremely heavy duty in medium corrosive fluids.

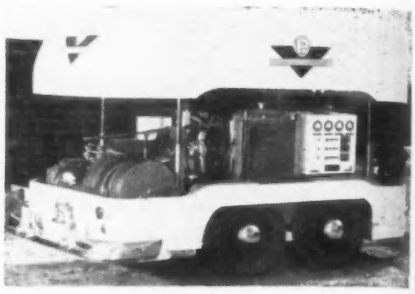
TYPE 78 Carbon-Chromium-Molybdenum Boron Alloy, normalized and tempered. For heavy duty pumping in non-corrosive or inhibited fluids.

Write for prices and complete literature today!

BUY FROM YOUR NORRIS DISTRIBUTOR

NORRIS QUALITY
SUCKER RODS
POLISHED RODS COUPLINGS

W. C. NORRIS DIVISION
DOVER CORPORATION
P. O. BOX 1739 • TULSA, OKLA.
BRANCHES: Great Bend, Houston, Kilgore, Odessa, Wichita Falls, Salem, Casper, Farmington



Pipe Inspection Service

A complete line of pipe inspection services, including magnetic and electronic-type inspections for remote field locations, is now being offered. Mobile units feature outstanding development, the Scanagraph. A unique, four-stylus electronic flaw dector, Scanagraph scans each 90 degree radius of pipe or tubing. Pick-up heads send electrical impulses to the recording equipment to the control console. (Pipe Inspectors, a Division of Plastic Applicators, Inc.).

For more data, circle E8 on postcard

Applicable Cutting Material

This cutting material, Servcoloy "S", can now be purchased for application to any make or type milling tool. Milling rates as high as 10 feet per hour are possible with this fast-cutting, tungsten carbide dressing material. Servcoloy "S" is purchased

HERE'S HOW IT WORKS

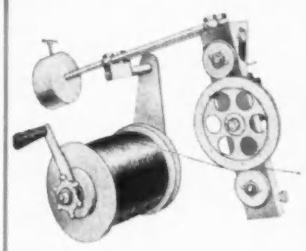
The Hydraulic Fluid-Drive Reel Assembly is driven by a hydraulic motor, powered from an engine-driven pump. A fluid by-pass, running parallel to the hydraulic system, incorporates a needle valve which may be preset to a specific shut-down pressure. If excessive loading of the wire line occurs, such as when the line wraps around tubing, the needle valve causes the pump to stall out and act as a hydraulic brake on the driving motor. This unique system gives a more accurate control of the speed and line pull of the measuring line reel going in and coming out of the well. Design flexibility of the Fluid-Drive Measuring Assembly provides for a completely packaged unit powered by gas/gasoline or diesel engines, as well as electric or air motors. Standard reel capacities include 24,000′ of .066″; 20,000′ of .072″; 17,000′ of .082″; 14,000′ of .092″ regular measuring line; or 4,900′ of 9/64″ cable or well shooter line.

BETTER MEASURING EQUIPMENT

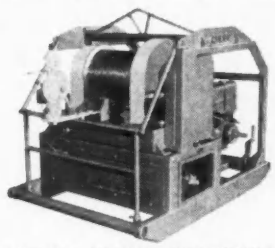
for demanding jobs, such as . . .

- Measuring Top of Cement
- Cable Tool Depth Measure
- Hole Deviation Tests During Drilling
- Reservoir Engineering
- Swabbing and Sand Washing
- Pulling Chokes and Gas Lift Valves
- Dual Zone Rework

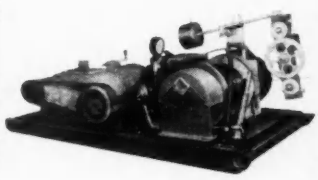
HALLIBURTON MEASURING ASSEMBLIES



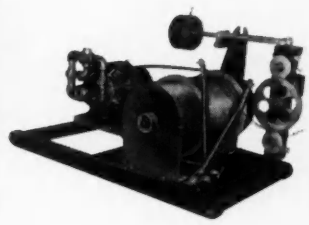
STANDARD MEASURING DEVICE for manual or cathead operation. Available in model shown, or in Heavy Duty type with hand brake.



ENGINE DRIVEN MEASURING ASSEMBLIES are available with diesel and gas/gasoline power in several sizes for light to severe wire line operation.



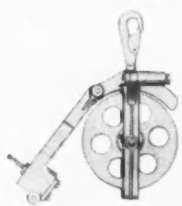
ELECTRIC MOTOR DRIVEN MEASURING ASSEMBLIES for use where electric power is the most practical application.



AIR MOTOR DRIVEN MEASURING ASSEMBLIES for pneumatic operation off rig air supply.

A FULL LINE OF ACCESSORIES

UNMATCHED MOBILITY can be provided any Halliburton Measuring Assembly with this light, two wheel, metal covered trailer.



LATCH TYPE HAY PULLEY AND LINE WIPER efficiently guides the line into the hole, automatically wiping it free of foreign particles which might damage the line or stuffing box.

STUFFING BOX AND STAFF ASSEMBLY available in models for working pressure of up to 5,000 psi and 15,000 psi.

MEASURING LINES are available in lengths up to 25,000′ in economical Regular Type Black, Galvanized Steel, Nickelply and Stainless Steel. Standard diameters are .066″, .072″, .082″, and .092″.

REPAIR PARTS AND SERVICE are immediately available through all Halliburton Field Locations.

Contact your Halliburton Representative for full details on a Halliburton Measuring Assembly. It can be tailored to your exact needs.

MEASURING EQUIPMENT

275 Service Centers . . . just minutes away from your well!

Halliburton
COMPANY • DUNCAN, OKLAHOMA

New equipment

by the pound in bars 18 inches long by approximately 1 inch wide. Application is accomplished by an acetylene torch. Complete instructions for use are provided with each Servcoloy "S" order. (The Servco Co. Supplements data on Pages 4913-4932, 1960-1961 Composite Catalog).

For more data, circle E9 on postcard

Liquid Level Control

A new single-stage, external-float cage liquid level control has been introduced to provide dependable liquid level control in petroleum and pipe line applications where vibrations and corrosion are serious problems. Design aim was to provide an anti-vibratory, corrosion-resistant liquid level control as a high-level alarm on scrubber service with 0.6 specific gravity hydrocarbon liquid at 500 psi, with high ambient temperature conditions. (Magnetrol, Inc. Supplements data on Pages 3464-3465, 1960-1961 Composite Catalog.)

For more data, circle E10 on postcard

JONES CONSTANT RESEARCH LENGTHENS ROD LIFE

From its beginning in 1894, Jones research has been working ahead anticipating tomorrow's sucker rod requirements. Deeper wells and heavier loads have created an ever-increasing demand for higher and higher strength rods . . . a demand that has always been satisfied by Jones advanced designs. Jones constant search for improved chemical composition and new processing techniques has provided the industry with tougher, longer-lasting sucker rods to meet every pumping requirement. Always specify Jones . . . sucker-rod specialists since 1894.

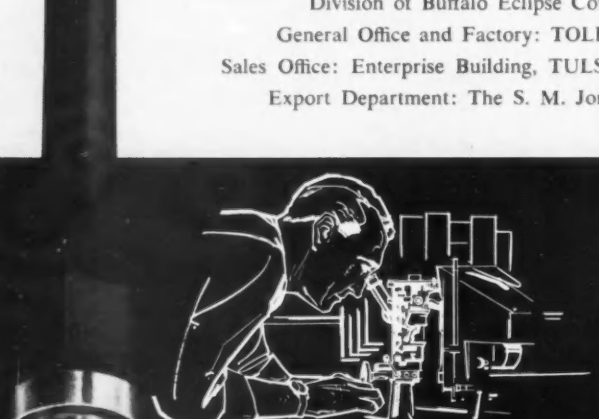
THE S. M. JONES COMPANY

Division of Buffalo Eclipse Corporation

General Office and Factory: TOLEDO, OHIO

Sales Office: Enterprise Building, TULSA, OKLAHOMA

Export Department: The S. M. Jones Company



JONES SUCKER RODS

135

Self Propelled Servicing Rig

This new self propelled servicing rig is powered by the all new Compact Caterpillar 1673, 220-horsepower diesel truck engine that furnishes complete power to FWD Carrier and Lee-built drawworks. The new rig is completely equipped with hoist-main drum, hoist sandline drum, right angle gear box, carrier unit and mast. (Mustang Tractor & Equipment Co.).

For more data, circle E11 on postcard

New Plastic Coating

A new thermo-setting plastic coating to protect internal drill pipe has been developed. Designated TK-34, it was developed to withstand the caustic effect of high alkalinity drilling fluids and the physical punishment inflicted in drilling operations. New coating has excellent adhesion to steel and withstands a 30 percent caustic soda solution at 200° F. It also performs well in pressures up to 10,000 psi at a temperature of 300° F. (Tube-Kote, Inc. Supplements data on Pages 5343-5348, 1960-1961 Composite Catalog).

For more data, circle E12 on postcard